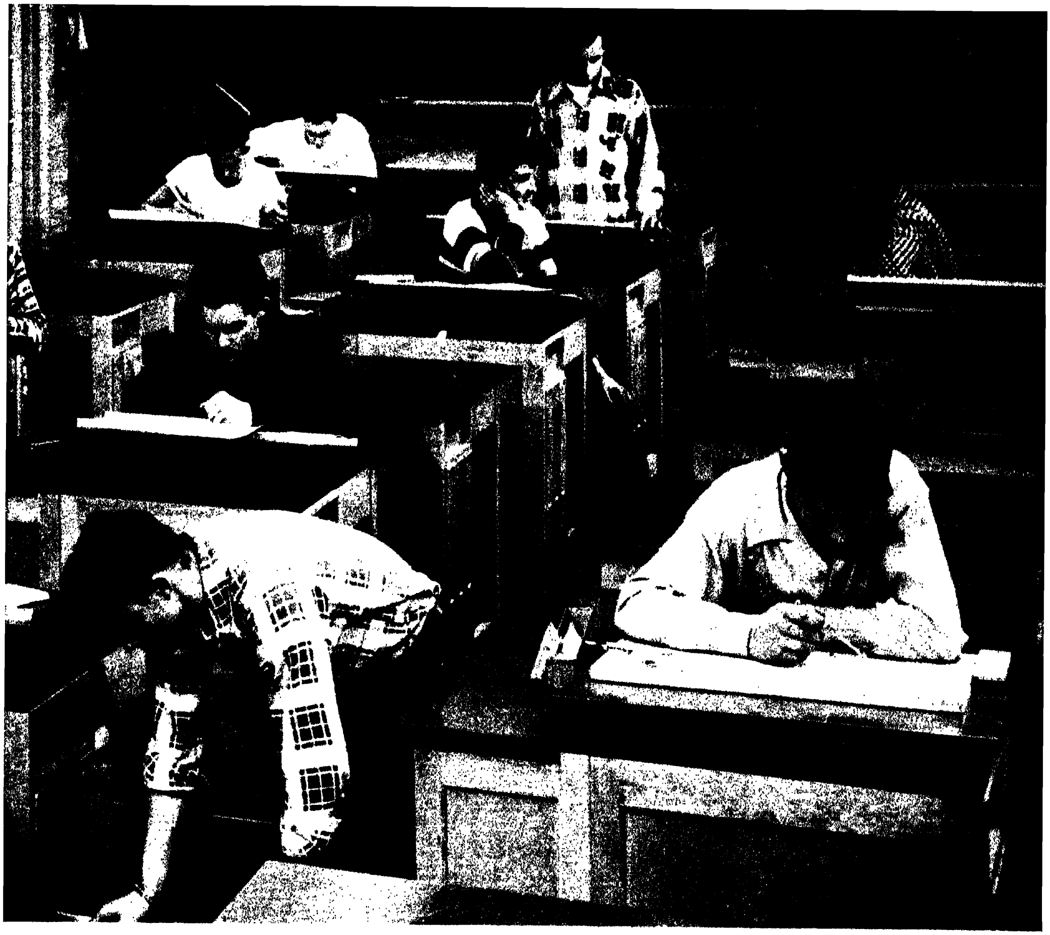
Drawing & Planning

FOR INDUSTRIAL ARTS

Drawing



& Planning

FOR INDUSTRIAL ARTS

By JOHN L. FEIRER · Head, Industrial Arts Department
Drawing Instructor, Western Michigan University, Kalamazoo

Chas. A. Bennett Co., Inc., Peoria, Illinois, Publishers

66VH110

Sixth Large Printing

PRINTED BY PHOTO-OFFSET IN THE UNITED STATES OF AMERICA

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The Plan of This Book

DRAWING AND PLANNING FOR INDUSTRIAL ARTS was written for students enrolled in shop and drawing classes that are a part of general education. *It is not a watered-down course in engineering drawing.* Its sole purpose is to help people, principally young people, to learn how to make and use drawings. Drawing is done so as to plan or represent a concrete object, not a complicated set of ideas or feelings. *How unlike a foreign language* and its many difficulties is this clearcut, direct method of making pictures of your plans so you can *see them on paper!*

The aim is to show you how to design, how to draw, how to plan, and how to use drawing in everyday life, in your own country or anywhere else in the world, in a language that is a part of your everyday life.

Notice in this book that the problems and activities are related to all kinds of high school activities and interests. Many of the drawings deal directly with the things you make in the school shop. Other drawings are related to health, safety, geography, science, and social science. Many others help you with hobbies, sports, and home and recreational activities.

In older books, a great deal of time is spent on unreal shapes and blocks to teach how to draw lines. In everyday life you have little use for these shapes and blocks, although you need to know how to make simple drawings, read drawings, and do sketching.

Should you learn *sketching and blueprint reading* before you *make drawings with tools?* Research has shown that you can do better if you learn first how to draw. Certainly you will be more successful in drawing lines and in securing correct proportion if you know how to use a rule! *Freehand sketching* is more difficult. Ask a friend who has no rule to make a sketch of his own home. You will find that the sketch bears little resemblance to the actual outline of the home. It is difficult to estimate sizes. Therefore, by learning first how to draw with a rule, either in making shop sketches or mechanical drawings, you learn a sense of proportion.

The book is divided into six major sections as follows:

Section I tells how to do all the first steps in drawing. It tells how

and why each simple procedure is used to complete all types of drawings. *Only the very simplest tools* you find in all shops and in many homes are included.

Section II covers the first skills needed to make a simple *shop* and *freehand sketch.* It also includes information on how to *design* and *plan a project,* a most important part of any industrial arts program.

Section III tells about the tools, equipment, and procedures in drawing that are not common to everyday life, but are very important to anyone who plans to be a *producer of drawings.* These apply to future engineers, draftsmen, designers, and others.

Section IV covers the use of drawing with other shop subjects that are included in a majority of industrial arts programs.

Section V deals with special phases of drawing, such as house planning, map drawing and graph reading, and making drawings that are used by people in everyday life.

Section VI includes information about drawing that gives you an appreciation of its importance in our industrial world. It also includes guidance information for those who might be interested in pursuing the study of drawing still further.

This drawing book is an attempt to make learning of drawing *simple rather than difficult,* and *easy to understand rather than baffling.* If your drawing course is successful, you will learn and want to use the things you have learned about drawing. It is hoped that this book will aid in reaching this goal.

Many companies and organizations supplied illustrations. A list is included in the appendix. Many of the drawings were made by Harry S. Brown, Jr.

Finally, but most important: This book could not have been prepared if it had not been for the years of work and thought given by your instructor and thousands like him. In colleges, elementary and high schools, and in industry, men have seen the need for more practical methods of teaching drawing for real life at the boy's age. The author has tried to represent them here by giving them a textbook they can use.

NOTE TO THE INSTRUCTOR:

There are many ways in which this book might be used as a text in teaching drawing and planning. The particular method you use will probably depend on many things. The age of the student may influence what you will teach first. Also, the amount of previous drawing experiences that the students have might change the order or sequence. Some drawing teachers have a favorite method of teaching. Some teachers prefer to begin by having the students make simple shop drawings and sketches. Others like to teach the use of sim-

ple drawing equipment first in making mechanical drawings. The exact kind of problems the students draw also will vary with the interests of the group.

The author has tried in this book to meet all of those needs. He has tried to make it flexible enough to meet the needs of students at all age and interest levels. At the same time, the book has been designed to cover the material that all drawing teachers would be likely to want in a drawing and planning text for industrial arts. For those who wish an organized first course in drawing, *Drawing and Planning Worksheets* are available. For the drawing teacher who wishes to plan his own outline, an attempt has been made to include enough different problems in each section to take care of any need. Also, the problems vary from very simple ones suited to beginning students to quite challenging ones for more advanced learners. By organizing the book into individual units and sections, an attempt has been made to make it easy for the drawing teacher to pick out the material he wants to use.

THE PHYSICAL FACTS OF DRAWING

The author assumes from his own experience and the experience of hundreds of other drawing teachers that a new student's first interest is in *drawing itself*. Therefore the book begins with physical facts about drawing. It is a new course to the student. It contains special features that other courses greatly depend upon but do not stress.

To begin the study of drawing and planning as if it were a mere branch of an art course is a mistake. The student is keyed up over the idea of using instruments and solving the small mysteries of a new subject. To start with an extended study of freehand sketching might cause your best boys to grow restless and to experiment with the use of drafting tools "on the side," while waiting to receive instructions on their use.

Good freehand sketching is not as easy as using simple instruments. It is extremely valuable if limited to broad, basic forms—such as altering a block to show how to divide an area into various forms. Many instructors like to start a first course this way. If so, the treatment in Section II can be used as freely as desired.

The entire book is based on more than 100 courses of study from carefully selected school systems of the United States. The author is an active instructor of drawing and planning on his own campus.

JOHN L. FEIRER

Contents

Section 1: BEGINNING DRAWING

HERE is a *preview* of the things you will learn in *beginning drawing* . . . what you should know and be able to do after you have studied the units in this section:

1. Why drawing is important in everyday life.
2. How to read a rule and make measurements.
3. How to use the common drawing tools.
4. A one-view drawing and how to make it.
5. Clear and accurate lettering.
6. Putting sizes (dimensions) on a drawing.
7. How to make a drawing to scale (an accurate drawing either larger or smaller than full size).
8. Patterns and how to make and enlarge them.
9. Working drawings and how to make them.
10. How to draw a project you can make in the shop.
11. Picture drawings and how to make them.
12. How to change a pictorial drawing to a working drawing.
13. How to make a complete set of drawings (assembly and detail) for a simple mechanical object.

Section I

1. Drawing—It's Important To You

Drawing is a way of telling and showing by the use of pictures instead of words or the real thing. Fig. 1-1. Have you ever tried to explain or describe some new gadget to a friend? Often you will say, "Just a minute and I'll show you!" So you get a piece of paper and a pencil and make a sketch of the object. You are *drawing*. A famous designer of cars has said, "Drawing is what you put on paper after you have done a lot of thinking." That's true because it's a way of getting ideas across to someone else.

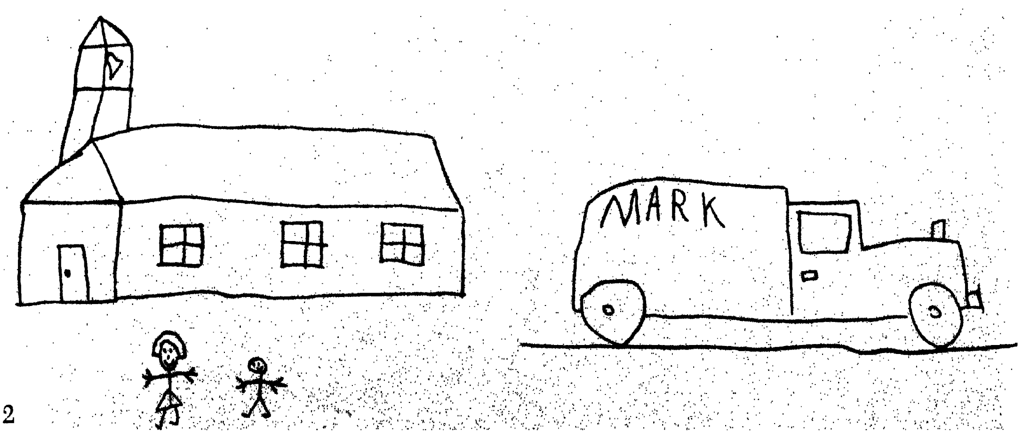
EXPLOSIVE INFLAMMABLE

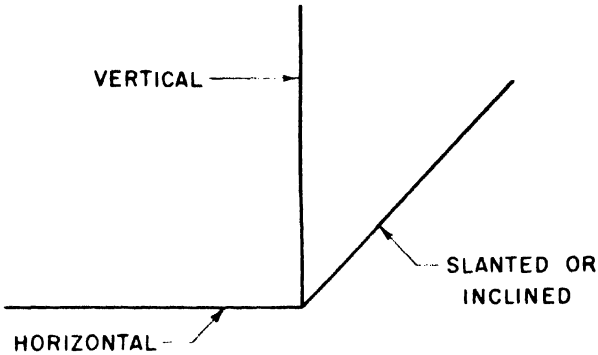
1-1. You wouldn't have to know how to read to get the meaning of these drawings.

All your life you have done drawing of one kind or another. Remember, when you were much younger, how you liked to use paper and pencil or crayon to draw pictures? Fig. 1-2. Most of these showed how a thing looked. It may have been your idea of a truck, a plane, your house, a person, an animal, or a tree. The drawing often was very crude but it was your idea. You told someone else about your idea by drawing it.

In this new adventure you will be interested most of all in drawings that tell how to make something. Drawings are of two kinds. *Illustrative* drawings show *how a thing looks* and *construction* drawings tell *how to make that thing*.

1-2. These are the actual kinds of drawings you used to make as a child. They were your ideas of what things looked like.



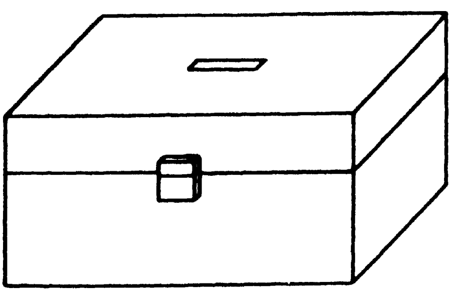


1-3. Most drawings include these three lines.

Sometimes one drawing can do both of these jobs!

WHAT'S IN A DRAWING

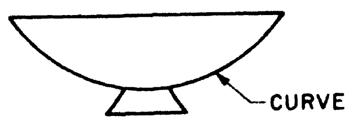
Drawing is not new to you or hard to learn. There are, however, many *things* to learn. These new ideas and ways of working will come easy and



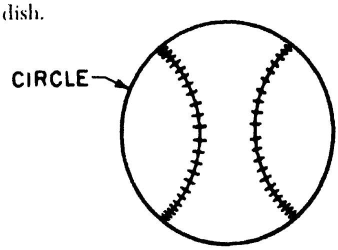
1-4. Vertical, horizontal, or inclined lines make up the shape of this fishing tackle box.

one at a time as you use this book and work with your instructor and the other fellows.

There are three basic things that go to make up all drawings. These are: 1. *lines*, 2. *dimensions* or *sizes*, and 3. *symbols*. The shape of an object is shown with *lines*. These lines are vertical (up and down), horizontal (right and left), slanted or inclined, and curved or circular (round). Fig. 1-3 shows the vertical, horizontal and slanted lines found in a fishing tackle box: Fig. 1-4. Curved

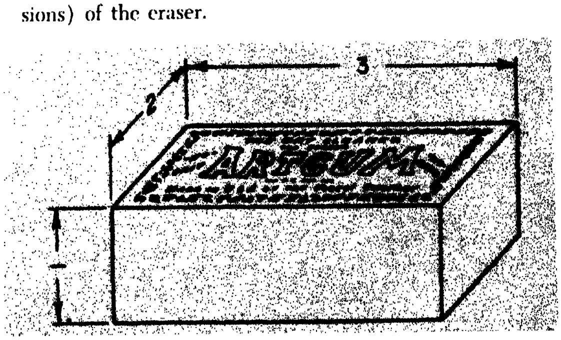


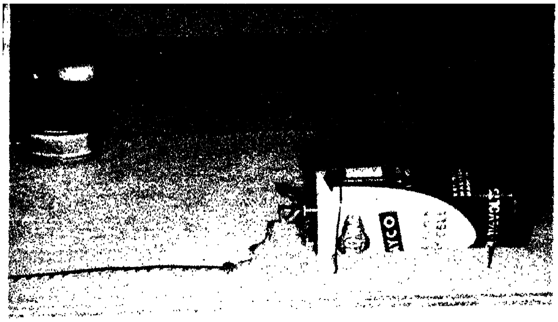
1-5. A curve shows the shape of this candy dish.



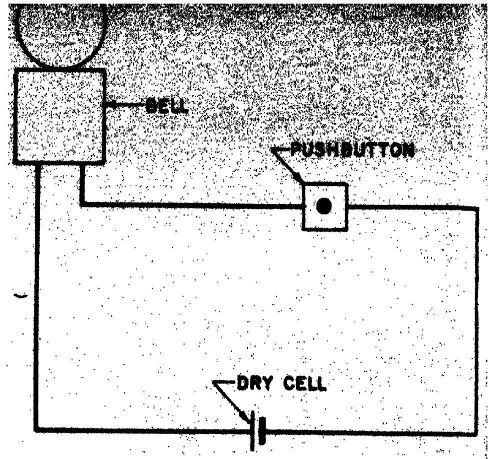
1-6. The baseball is a circle shape.

1-7. These numbers give the size (dimensions) of the eraser.





1-8. Parts of a simple bell circuit as they really are.



1-9. A drawing of the bell circuit using symbols. This is called a schematic diagram or drawing.

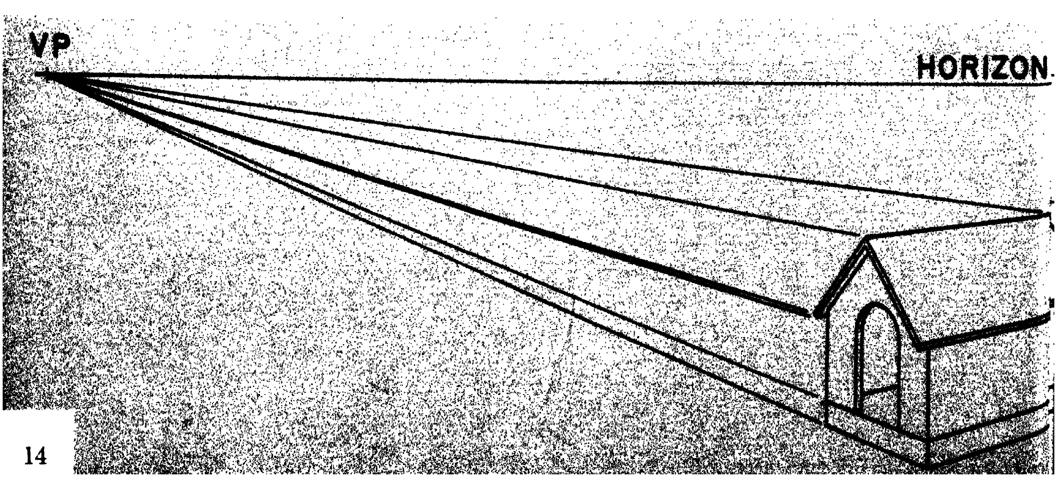
or circular lines show the shape of such things as the sides of a fruit dish or a baseball. Fig. 1-5. Fig. 1-6. Lines also tell different other things by the way they are drawn. You will see this later.

Dimensions tell how big or what size a thing is. Dimensions are the numbers you see on a drawing. Without these it would be impossible to build or make things correctly. Fig. 1-7.

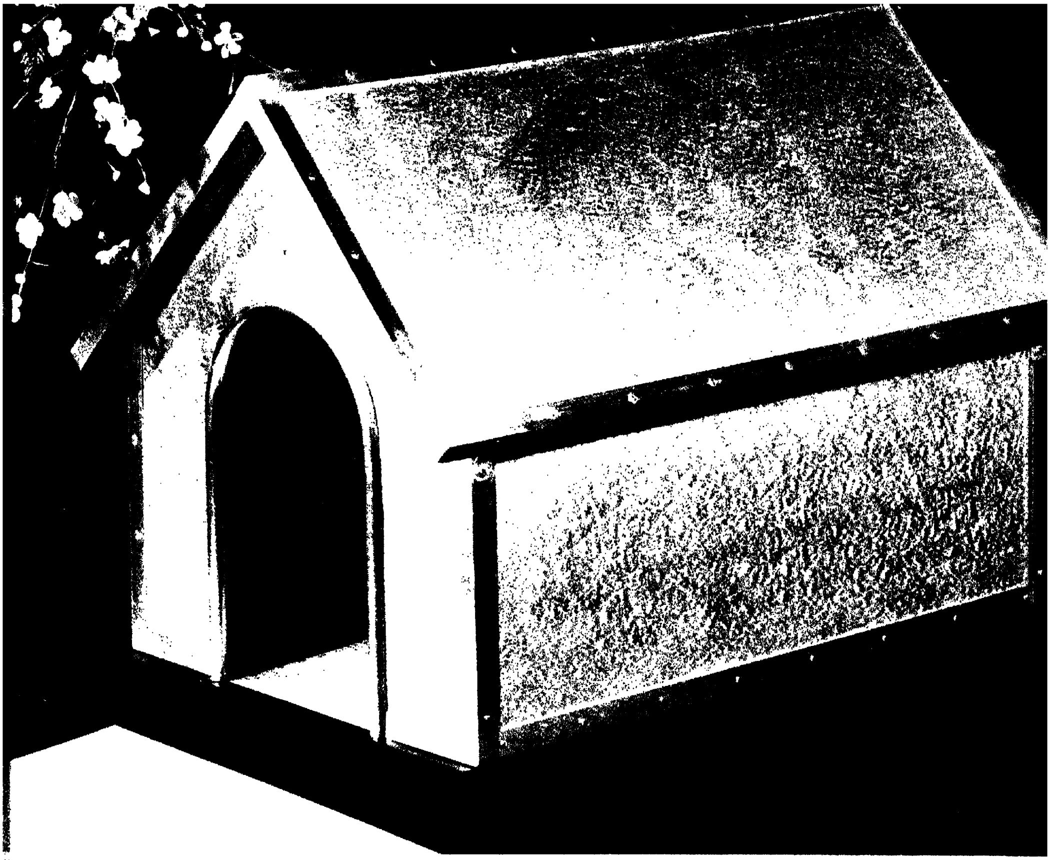
The third new idea is *symbols.* Most things are too difficult or take too much time to draw exactly as they are. Therefore you will draw symbols instead. A symbol is a very simple drawing of the object. Fig. 1-8 is a photograph of a bell, push button and battery connected to operate. This is the way you would draw this with symbols: Fig. 1-9. In each area of drawing there is a group of different symbols.

WHAT ARE THE KINDS OF DRAWINGS?

Figs. 1-10 to 1-14 are a photograph of a dog house and 4 different kinds of drawings of it. Notice that three of these look a good deal like the picture. These we call *pictorial draw-*

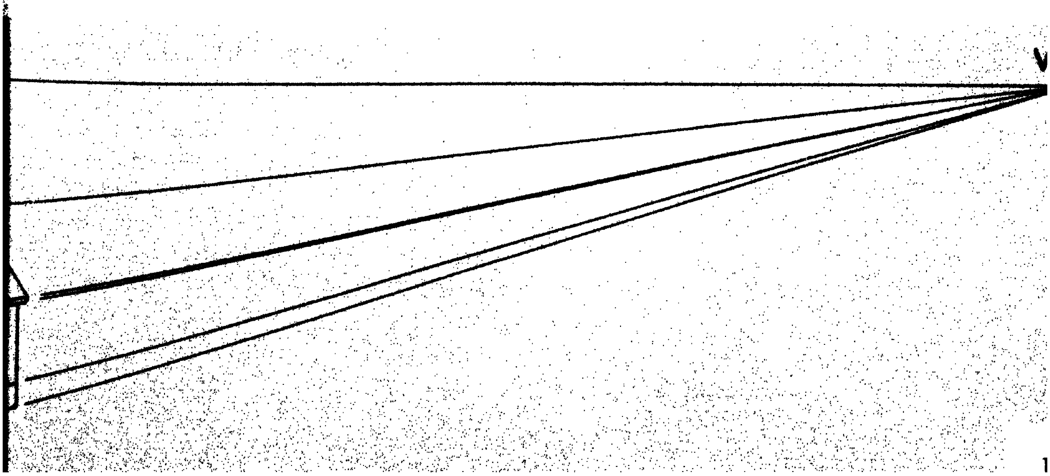


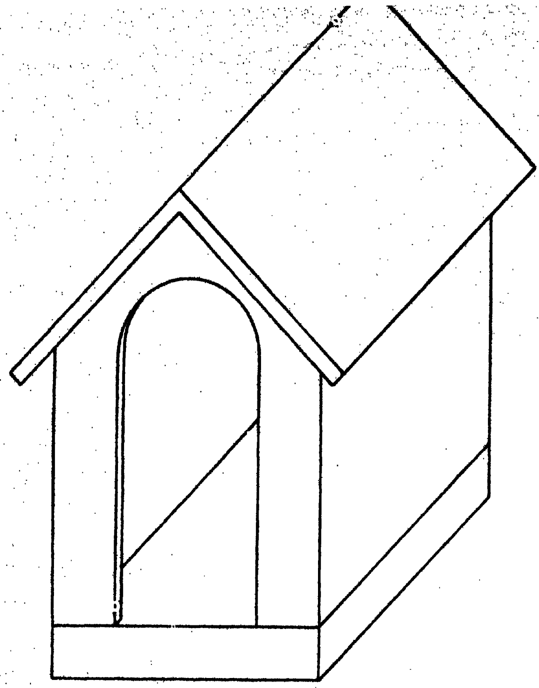
1-10. A *perspective* drawing of the dog house.



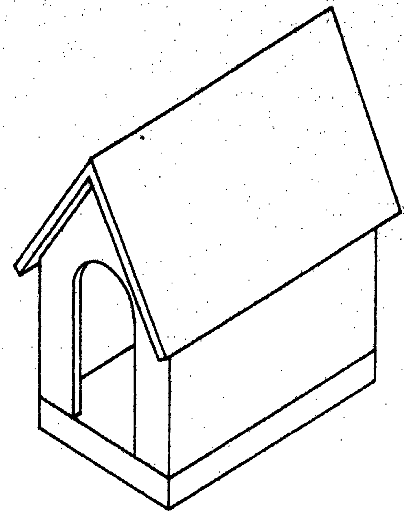
1-11. The dog house.

ings. The one that is most like the photograph is called a *perspective* drawing: Fig. 1-10. The other two picture drawings are called *cabinet* and *isometric:* Figs. 1-12 and 1-13. You will learn more about each of these later. The fourth drawing looks the least like the photograph but it





1-12. *Cabinet* drawing of the dog house.



1-13. An *isometric* drawing of the dog house.

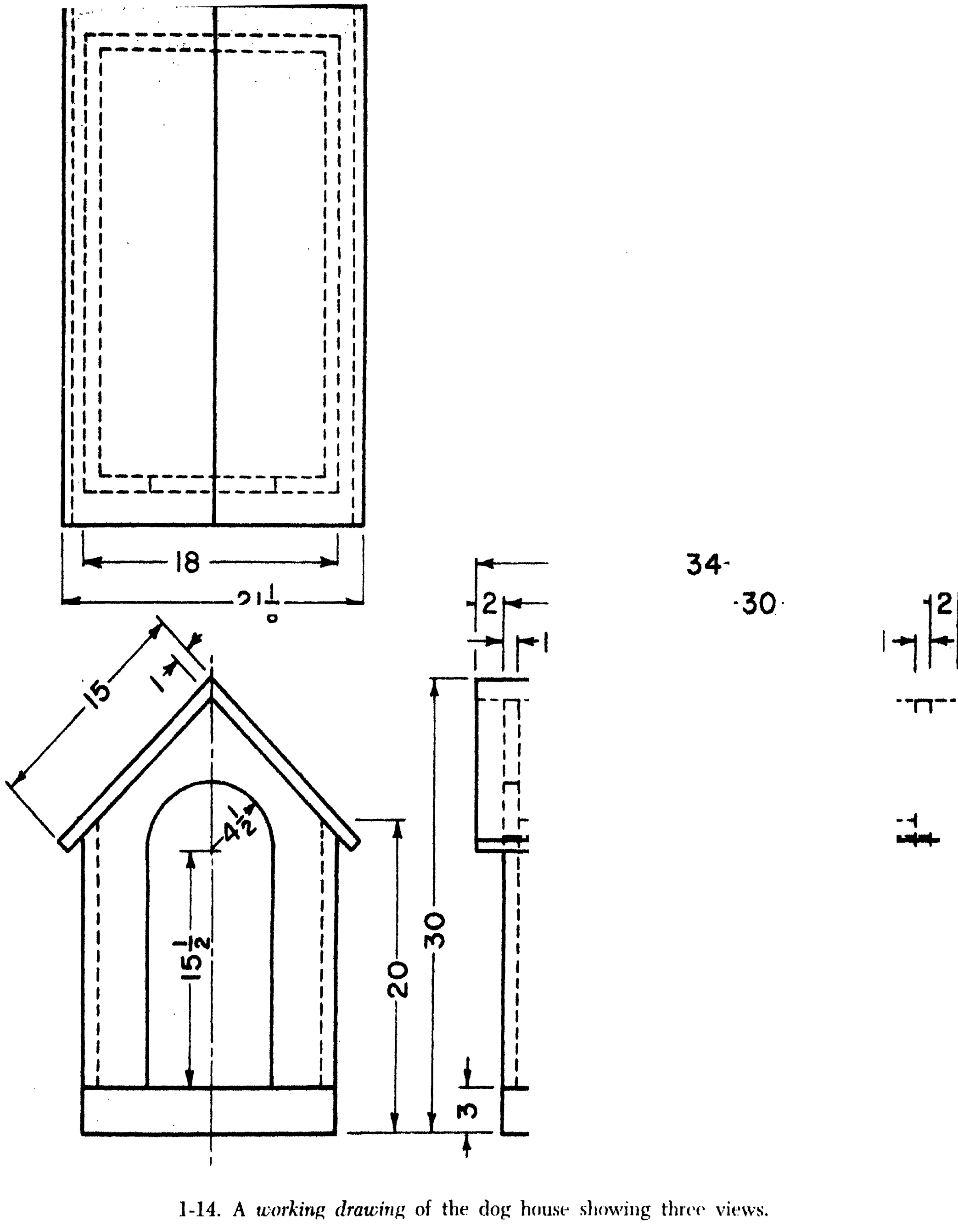
is the most useful: Fig. 1-14. There are several names given to it. It is often called a *working drawing*, since it is used so often by workmen and builders. Others say it's a *multi-view* (many view) drawing, since it usually shows two or three views of the object. Still other persons use a different phrase to describe how the drawing is made—*orthographic projection*. Let's call it a *working drawing!*

WHY LEARN TO MAKE AND READ DRAWINGS

This is the age of marvels—atom power, jets, and electronic devices that work wonders. You're living in this wonderful age. To live better and enjoy life more you will need to know how to make and read drawings. Why? Here are only a few of the many reasons:

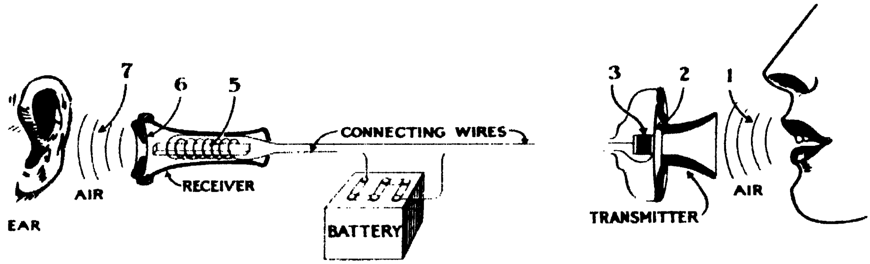
1. To read well you must understand drawings. You can't pick up a book or magazine today without seeing a drawing of some kind. A science book has many drawings that show how things work. Fig. 1-15. A popular magazine may have drawings of new projects. Figs. 1-16 and 1-17. Your mathematics book contains drawings of many kinds of *geometric* shapes. A geography book is full of maps. Fig. 1-18.

2. To understand how things operate and how to use them. When you buy a new product you find with it an instruction sheet. It usually contains a drawing to tell you how to put the product together,

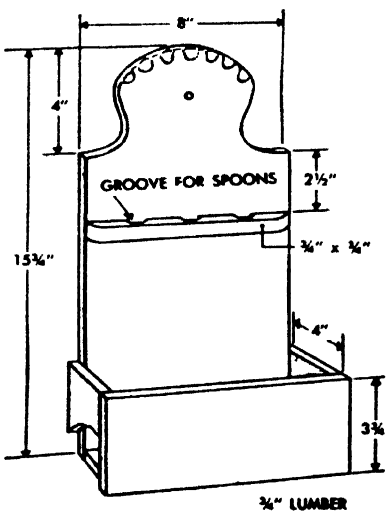


1-14. A *working drawing* of the dog house showing three views.

how to take care of it, how to repair it, or how to order a new part for it. Mechanical or electrical things can be explained best by drawings. Here is a drawing from a woodworking book to tell how to bore a hole. Fig. 1-19, Figs. 1-20 and 1-21 are from an outboard motor manual.



1-15. A simple telephone circuit. Voice impulses set up sound waves in the air, vibrating the diaphragm of the microphone, changing its internal resistance, and varying the current in the circuit. This changes the magnetic pull on the diaphragm of the receiver and results in sound waves in the air for the ear at the other end.

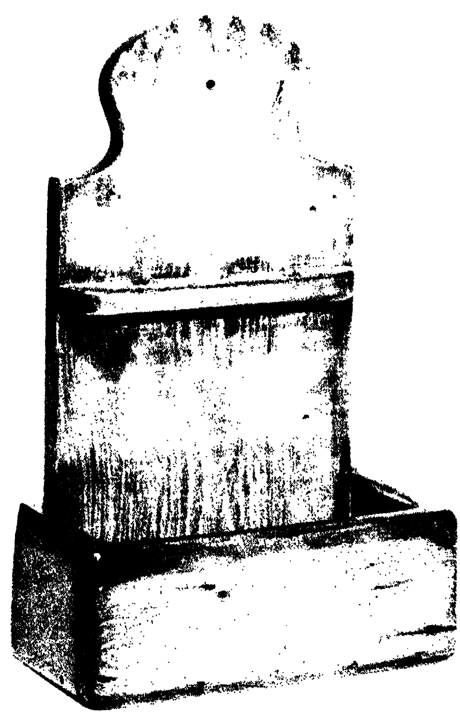


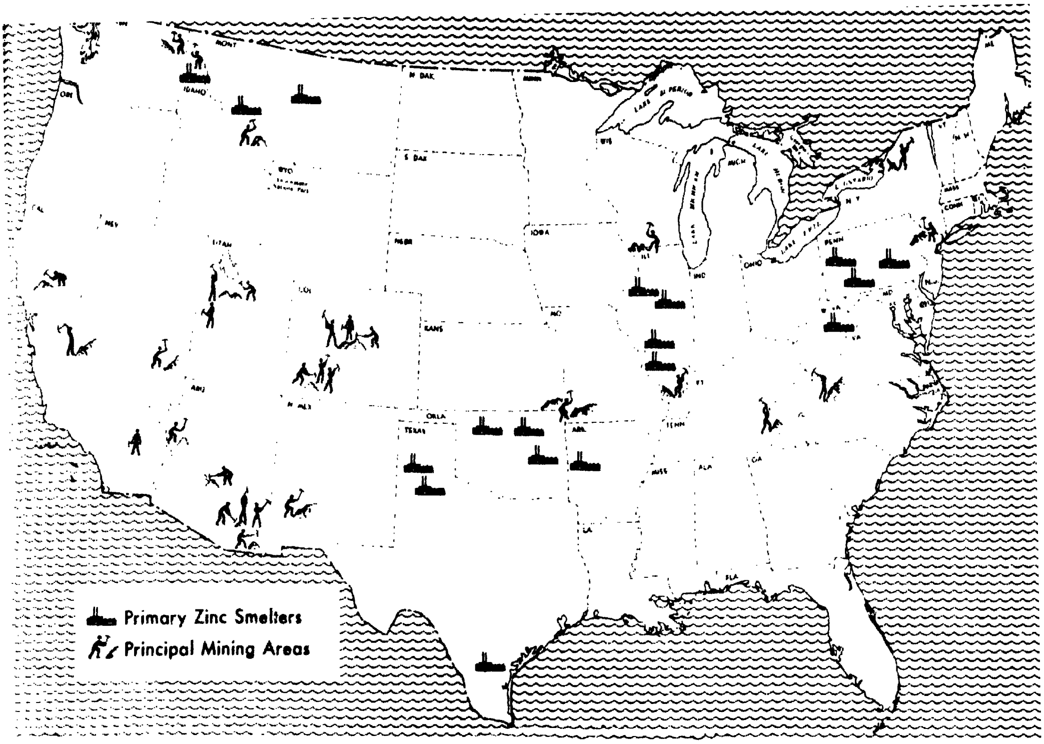
1-16. Pictorial drawing of the spoon rack that can be used to build the project.

3. To plan wisely and well. In order to take a trip you must be able to read a road map drawing. Fig. 1-22. Anyone who plans to build a cabin needs to make a simple sketch of it and be able to read the finished plan. Figs. 1-23 and 1-24. Also, to play any game you must be able to read diagrams or drawings of the plays. This helps you to plan your play and to play wisely.

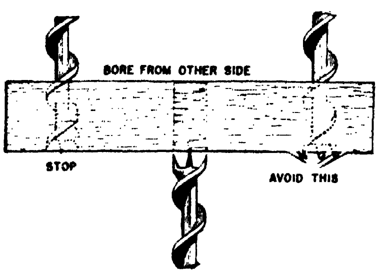
4. To build or make things. Everything that is made must first be drawn. In your shopwork you need a drawing or sketch of each project.

1-17. Spoon rack.





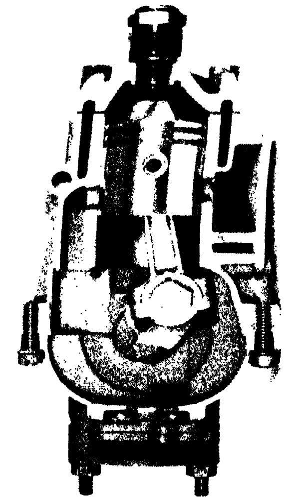
1-18. This special map of the U. S. shows important information about zinc, a metal that is used in solder, on galvanized iron and in many other places in the shop.



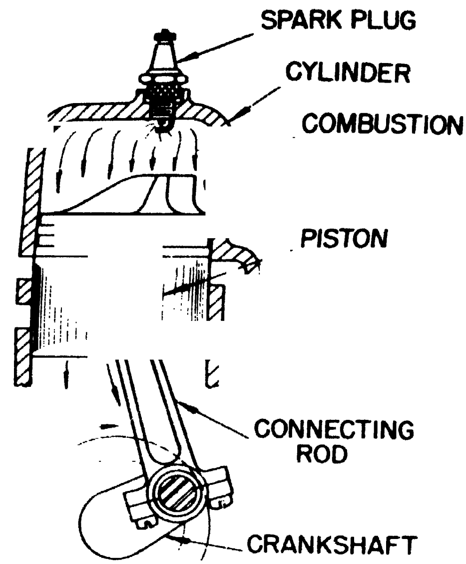
1-19. The correct and incorrect way of boring a hole in wood. How many words would it take to explain this?

In woodwork it might be this spice rack, or in metalwork, this towel rack: Figs. 1-25 to 1-28. If you are able to make a good sketch or drawing the job is well started. In American industry, drawings are needed for all progress. Everything that is made, manufactured, or built must first be put on paper as a drawing. When a new automobile or airplane is to be built, thousands of drawings of all kinds must be made. Everyone who helps to build it must know either how to make or read these drawings. The designer, engineer, and draftsman must know how to carry out the idea. They also make sketches and check them and make the finished drawings.

The men who purchase supplies and materials need to be able to read drawings. The skilled workmen responsible for making the product would be lost without drawings.



1-20. A photograph showing the cutaway of an outboard motor. Important parts are exposed.



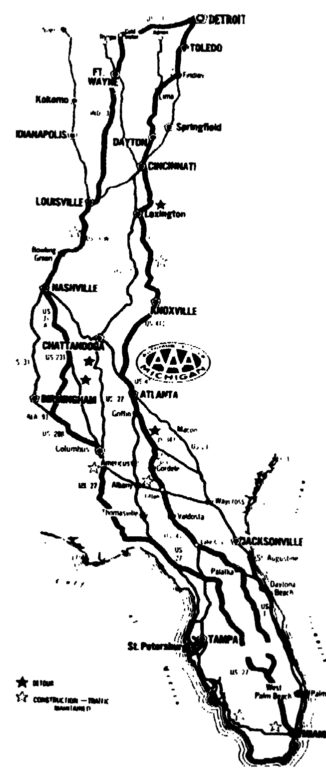
1-21. A cutaway (section) drawing naming these important parts shown in Fig. 1-20.

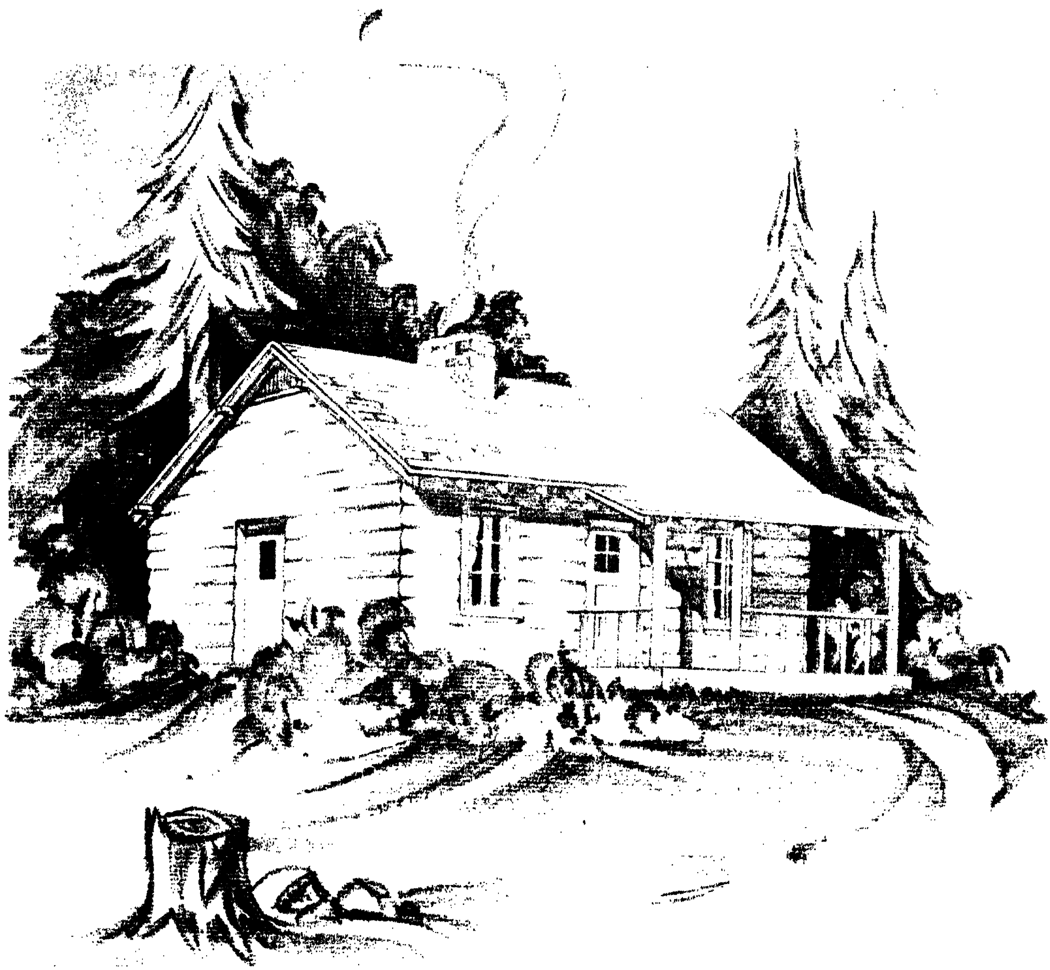
Drawings are the master plans that everyone follows.

WHERE WILL YOU USE DRAWINGS

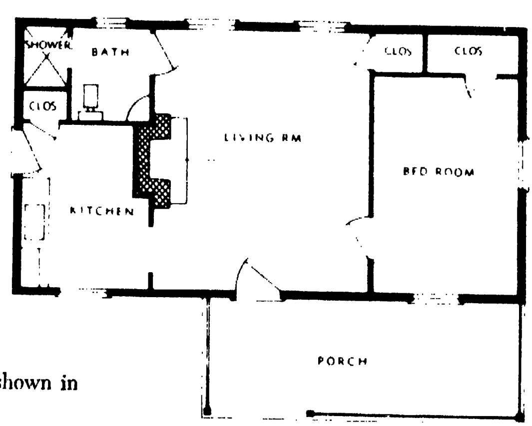
The most important reason for learning drawing now is to use this knowledge in your shopwork. It doesn't make any difference what materials you are going to use. First you learn to make the drawing from which the project is to be built. You will also use these drawing skills in other school activities—in science, mathematics, geography, and social science. Many of the drawings will be useful in your hobbies, in sports, and in the things you do around your home. You will find that this book contains drawings representing all kinds of activities.

1-22. This is the kind of map that is very useful in planning a trip.

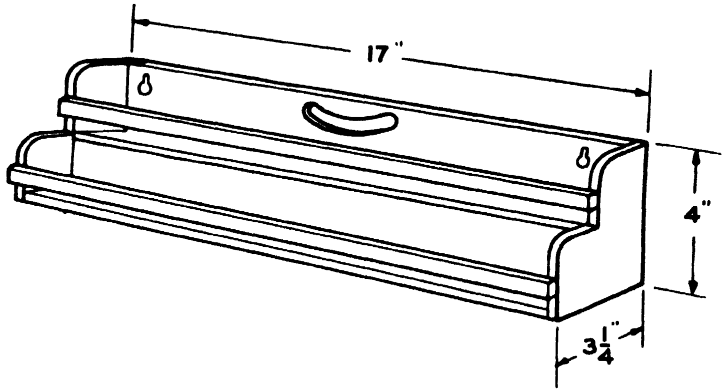


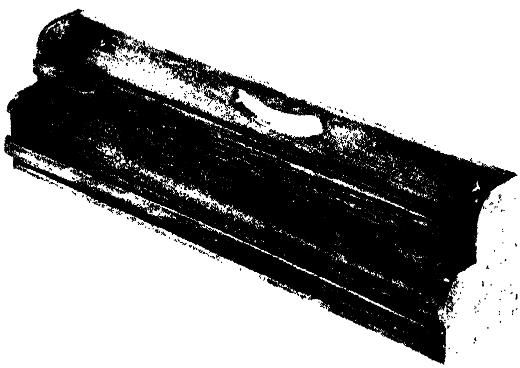


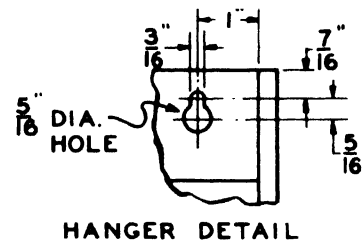
1-23. A rendering, or pictorial drawing, of a simple cabin.



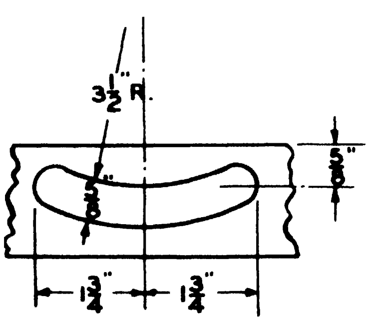
1-24. The floor plan of the cabin shown in Fig. 1-23.

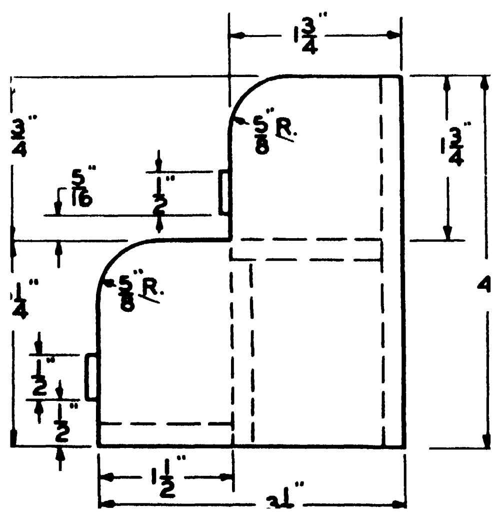




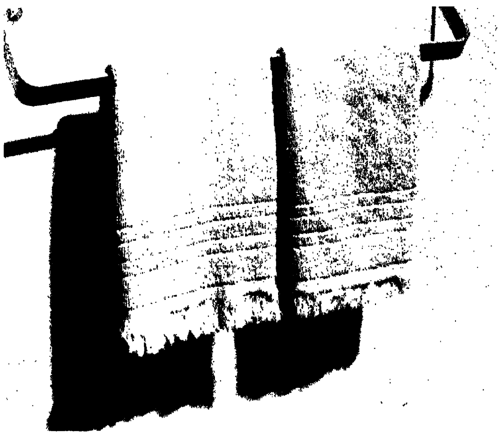


1-25. Spice rack.



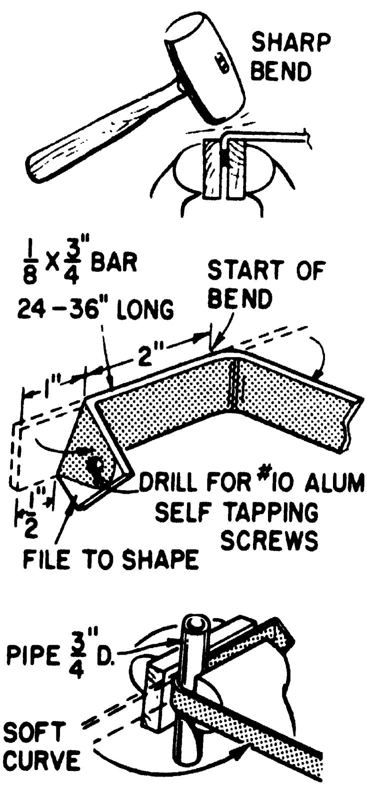


1-26. Pictorial and view drawings of the spice rack. Often two different kinds of drawings will be used to show how to build the object.



1-27. Towel rack.

1-29. A draftsman at work.



1-28. This drawing can be used to plan the materials needed and the method to follow for making the towel rack.

You learn drawing also for future use. Many of you may some day work at a job in which making and reading drawings are a very important part. This is especially true if you become an engineer, architect, designer, draftsman, or skilled workman. Fig. 1-29.

Section I

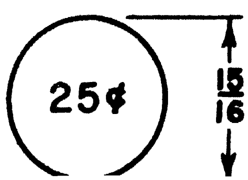
2. Reading a Rule and Making Measurements

How tall a

you may be or shorter than the student next to you. Your exact height, however, can be found only by measuring.

What's the exact diameter (dis-

of a quarter? It's less than a 50¢ piece and more than a nickel. Fig. 2-1. Actually, when you will find that the quarter is $\frac{15}{16}$ inch in diameter.

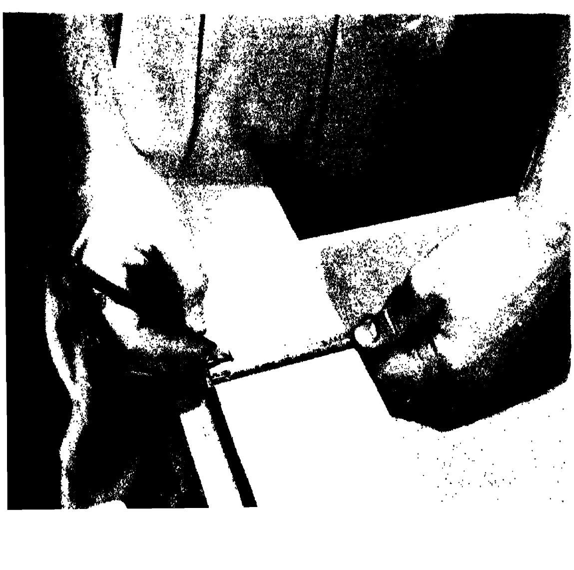


2-1. The exact size of any object can be found by carefully measuring the object itself.

In drawing and all shopwork you must be able to measure. That means that you need to know how to read a rule. Fig. 2-2. It is surprising how few people ever learn to read a rule well. You can get very good at it with a little practice.

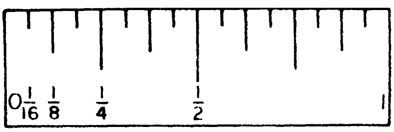
HOW MEN LEARNED TO MEASURE

Men have always wanted to know the size of things. Hundreds of years ago that was very difficult. There was no standard system or way of measuring. According to history the Romans invented the inch. They decided that an inch was to be the width of a grown man's thumb. There is a story that King Alfred of England decided what the foot was to be. He said that a foot would be the distance from the heel to the toe of his own foot. King Henry I decided that a yard would be the distance from the tip of his nose to the end of his thumb. All of these people were trying to set up a standard of measurement.



2-2. You can't learn to draw or build anything until you've learned to measure.

Today we use the English system of measurement. It includes the yard, the foot, and the inch. All you have to do is learn how to use this system. That means you must learn to read a rule accurately. Most of the rules used in the drawing room are one foot, or 12 inches, long. Measurements are usually given in feet, inches, and parts of an inch. Fig. 2-3. If the measurement is in feet, you place a single mark (′) after the number. If the measurement is in inches, you place a double mark (″) after the number. That means the measurement is in inches only. You should not find it hard to measure in feet and *exact* inches. You already know that there are 12 inches in a foot and 3 feet (or 36 inches) in a yard. Many people, however, have trouble measuring in parts (or fractions) of an inch.

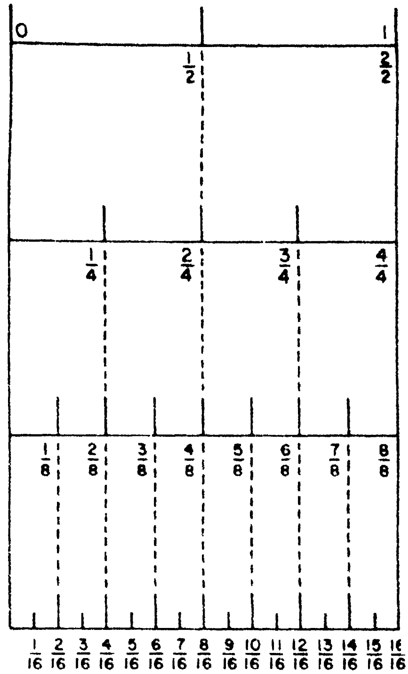


ENLARGED INCH

2-3. Study this enlarged drawing of an inch. If you can learn to read the parts of an inch, you will have little difficulty in reading a rule.

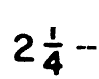
READING A RULE

Let's take a look at the enlarged chart shown in Fig. 2-4. Notice that the distance between 0 and 1 is one inch. At Line A you see that the inch is divided in half. Each half is one half inch (½″). This half-inch division line is the longest line on the rule between the inch marks. At Line B the inch is divided into four equal parts. Each part is one fourth (¼″). The first line is ¼ inch, the second line is 2/4, or ½ inch, the third line is ¾ inch. At Line C, you will notice that the inch is divided into eight equal parts so that each small division is one eighth inch (⅛″). Two of these divisions make 2/8, or ¼, inch (as shown on Line B). Four of these divisions make 4/8 inch, or 2/4 inch, or ½ inch (½″). At Line D, the inch is



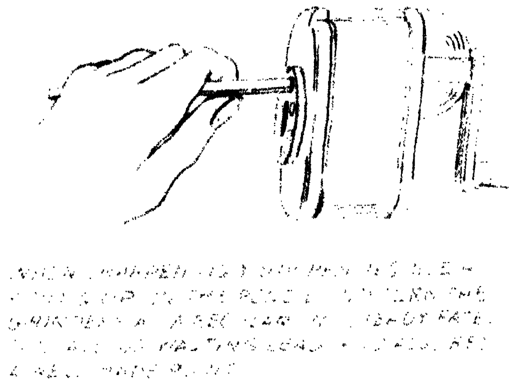
2-4. Chart showing how the inch is divided into smaller and smaller units.

2-5. Use a rule to measure this line. It is 2¼″ long, isn't it?

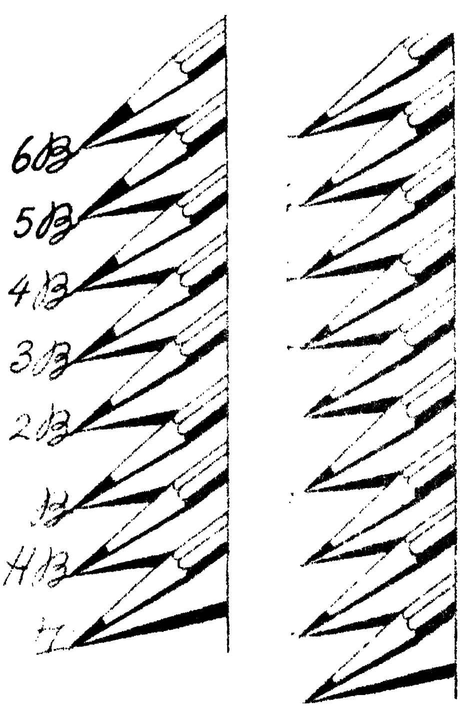


divided into 16 parts. This is usually *the smallest division found on rules used in drawing. Notice again that* $\frac{4}{16}''$ *is equal to* $\frac{2}{8}''$, *or* $\frac{1}{4}''$. *One line* past $\frac{1}{4}''$ is equal to $\frac{5}{16}''$. You will see on your rule that between each one-inch (1″) mark, the half-inch ($\frac{1}{2}''$) mark is the longest one. The quarter-inch ($\frac{1}{4}''$) mark is the next longest, the eighth-inch ($\frac{1}{8}''$) mark the next and the sixteenth-inch ($\frac{1}{16}''$) mark is the shortest.

To read a part or fraction of an inch, count the number of small divisions beyond the last inch mark. For example, when measuring this line, Fig. 2-5, you will find that it is 2″ plus 4 small divisions. This is $\frac{4}{16}''$, which is the same as $\frac{2}{8}''$ or $\frac{1}{4}''$. The line measures $2\frac{1}{4}''$. One small division past $\frac{1}{2}''$ would be $\frac{9}{16}''$ ($\frac{8}{16}+\frac{1}{16}$).



2-7. Using a pencil sharpener.



2-6. Here you see the different grades of hardness and the weight of line each grade will make.

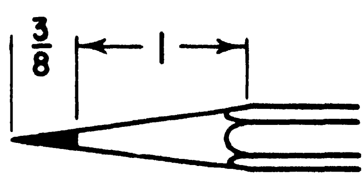
TOOLS AND MATERIALS

For this first activity in drawing you will need four things: a rule, a pencil, an eraser and a piece of plain white paper. Here is what you should know about rules and pencils.

Rules. In beginning drawing an inexpensive 12″ wood rule is all that is needed. Fig. 2-11. This is the kind you use at home and in school. In more advanced drawing you might use the architect's scale. Fig. 3-13. You will find more information about this and other scales in Section III, Unit 24.

Pencils. Pencils are made in many grades of hardness. The harder the

2-8. A pencil point correctly sharpened.



pencil the lighter the line it makes. The lead of a pencil is made of graphite, clay, and wax. The more clay *it contains the harder the lead.* Pencils used by draftsmen are numbered from 9H (very hard) to 6B (extremely soft). Fig. 2-6. The ordinary writing pencils are numbered 1, 2, and 3. Number 3 is hardest and is equal to 2H; 2 is equal to HB, and 1 is about the same as 2B. You should use an H, 2H or No. 3 pencil. The number or grade is stamped on the pencil. Always sharpen the end away from the grade stamp. This is important so you will always know the kind of pencil you are using.

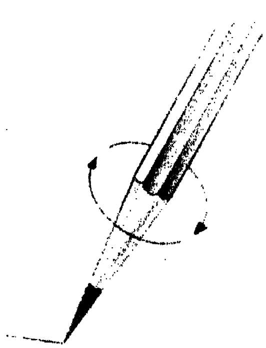
The simplest way to remove the wood is to use a pencil sharpener. Fig. 2-7. A knife can also be used. The pencil should be sharpened to a shape shown in Fig. 2-8. To keep a cone-shaped point on the lead, rotate the pencil slowly as you rub the point on a small sandpaper pad. Fig. 2-9. Always keep the lead sharp. You can also use a fine file to do this. WARNING: Be sure to keep the dirt away from your drawing board or paper. Hold the pencil about 1½" from the point between the thumb, forefinger, and third finger. Slant the pencil in the direction you move it, at an angle of about 60 degrees. Rotate the pencil slightly as you draw the lines. Fig. 2-10. This will keep it sharp longer and you won't flatten out the lead so fast. You will also get a sharper and more accurate line.

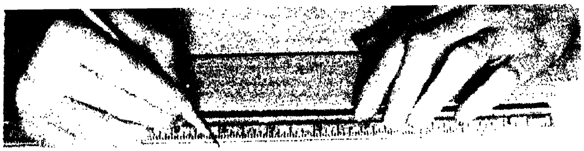
DRAWING A STRAIGHT LINE

Can you draw a straight line of a certain length with a rule and pencil? You can't make drawings until you can do this simple but important thing. Be sure the rule is in good condition. Hold the rule firmly against the paper. Mark a point at the zero line on the rule. Mark another point at the

2-9. Using a sandpaper pad or pencil pointer to keep the point of the lead sharp. The felt at the end removes the dust after the pencil is sharpened.

2-10. Rotate the pencil as you draw a line.





2-11. Marking the end of a line. Always make sure that the mark is directly in front of the correct measurement on the rule.

other end of the line. Fig. 2-11. If you want to draw a line $3\frac{5}{8}$" long, place the second point exactly 3" plus 10 small divisions. Place the point of the pencil at the zero mark. Hold the lead firmly against the edge of the rule. Move the pencil, turning it slightly until the other point is reached. Stop right at the second point.

MEASURING

Now let's see if you can measure accurately. Here are some lines that represent the diameter, thickness, width, or length of some common things you see every day. Fig. 2-12. Hold the zero mark of the rule at one end of the line. What is the length? Always reduce the fraction to the smallest denominator possible. If it is $\frac{12}{16}$", it should be written $\frac{3}{4}$". Find out what each length of line is and write the name of it on a piece of paper. Measure to the cl

2-12. Measure these lines to find what common items they represent:

Width of a business envelope: $4\frac{1}{8}$"
Height of a 3-cent postage stamp: 1"
Diameter of a fifty-cent piece: $1\frac{3}{16}$"
Width of a dollar bill: $2\frac{9}{16}$"
Diameter of a quart paint can: $4\frac{3}{16}$"
Width of a hack-saw blade: $\frac{1}{2}$"
Width of an electrical switch plate: $2\frac{3}{4}$"
Thickness of a 2 x 4 (lumber): $1\frac{5}{8}$"
Width of a 2 x 4 (lumber): $3\frac{5}{8}$"

Section I

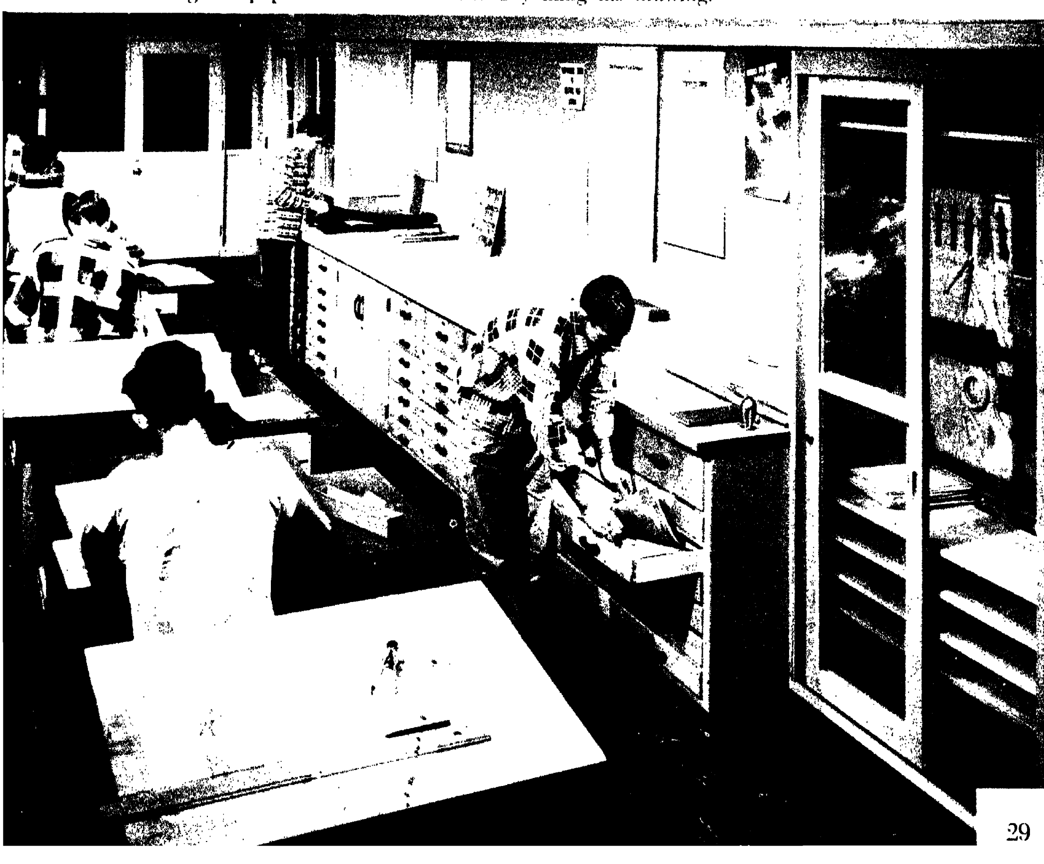
3. Drawing Vertical and Horizontal Lines

You are ready now to learn about some of the simplest tools used in making drawings. In this and the next three units you will get to know all the tools and instruments needed to begin. Section III gives some drawing instruments used by engineers, draftsmen, designers, and architects.

COMMON TOOLS AND MATERIALS

Drawing Bench. You will probably do your drawing at a bench similar to the one in Fig. 3-1. You can fasten your paper directly to it. The bench is a convenient height to make your drawing position comfortable.

3-1. A corner of a modern industrial arts drawing room. Note the one boy using the paper cutter and another boy filing his drawing.



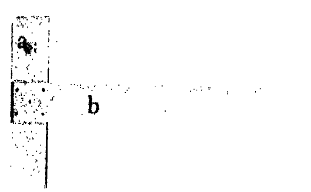
3-2. This kind of stand can be used to hold a drawing board.

A drawing bench is not necessary, however. Good drawings can be made in the shop or at home on a shop bench or ordinary table. Sometimes a stand can be used to hold your drawing board. Fig. 3-2.

Drawing Board. A drawing board is made of some softwood, such as basswood or white pine. Fig. 3-3. The surface must be smooth and the edges straight. Most boards are made of several horizontal pieces with a vertical piece (cleat) at either end. This cleat provides a smooth edge for the T square. Drawing boards come in various sizes from 12" x 17" to 31" x 42". The common size is 18" x 24". You do not need a drawing board if a drawing bench is available. At home or in the shop a rectangular piece of ¾" plywood will make an adequate board.

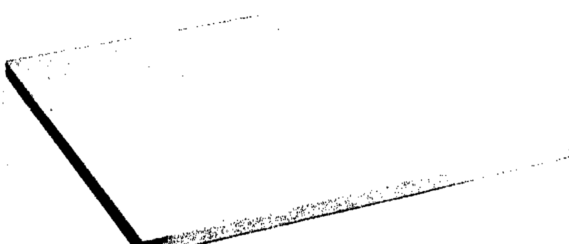
T Square. *The T square has a head and a blade that are fastened* at right angles. Fig. 3-4. The more expensive kinds have a transparent edge on either side of the blade. Fig. 3-5. The T square is used to draw all *horizontal* lines. With a *triangle* and a *T square* you can draw *vertical* and *slanted* or *inclined* lines.

To use a T square, place the head against the *left* edge of the drawing board or bench. Apply slight inward pressure to the blade with your left hand. Fig. 3-6. The head should always be held against the edge of the board. The T square can then be slid up and down to draw hori-



3-4. Parts of a T square: (a) head and (b) blade. Use a T square with great care. Never drop it or use it as a pounding tool. It is important that the head and blade be tight for good work.

3-3. A drawing board.



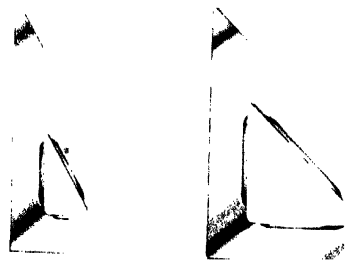
3-5. A more expensive T square.

3-6. The correct method for using the T square if you are right handed. Note that the pressure is applied inward with the left hand. Hold the pencil at an angle of about 60 degrees to the paper.

3-7. The correct method of using the T square if you are left handed.

zontal lines at any location. *If you are left handed* (and one in ten persons is), just reverse this position. Place the head of the T square against the right edge and apply pressure with your right hand. Fig. 3-7.

Triangles. There are two right triangles used in drawing. One is called a 45-degree triangle and the other a 30-60 degree triangle. Fig. 3-8. These triangles are transparent and come in various sizes. An 8″, 10″, or 12″ triangle is a good size to have. You will learn a good deal about triangles in the next unit.

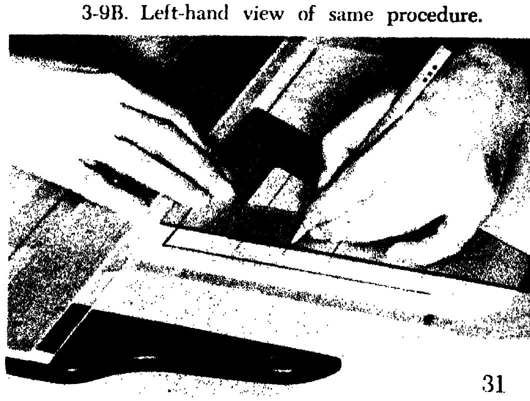


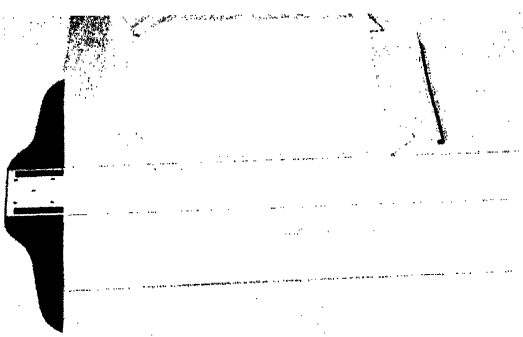
3-8. The 30-60 degree triangle and the 45-degree triangle.

Triangles are used to draw *vertical* lines. If you are right handed, place the triangle as shown in Fig. 3-9, with the tapered side toward your right hand. Reverse this if you are left handed. Apply slight inward pressure to the blade of the T square with your thumb and little finger. Hold the triangle firmly against the upper edge of the T square blade with your other fingers. Now you can slide the tri-

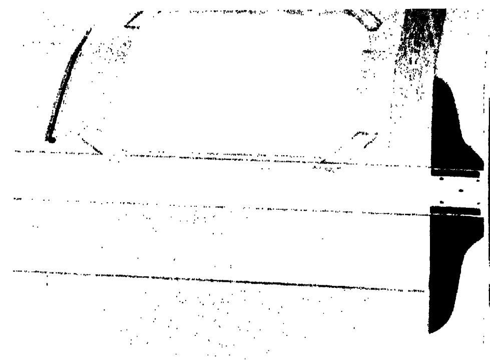
3-9A. Drawing the vertical line with a triangle. One hand holds the T square and triangle. Note that the pencil is held at an angle of about 60 degrees. The line is drawn from the bottom to the top.

3-9B. Left-hand view of same procedure.





3-10A. Paper attached to drawing board with four pieces of tape. The T square, simple rule and pencil are also shown.



3-10B. Left-hand

angle to the right or left. You can also move both the triangle and T square up and down with one hand. Try this.

Paper. Drawing paper is made in four colors: white, cream, light green, and buff. It comes in various weights, or sheet thicknesses, and in many different sizes. The most common are 8½" x 11", 11" x 17", and 17" x 22". You will probably use sheets 8½" x 11", or cut the sheets from 11" x 17" paper on a paper cutter.

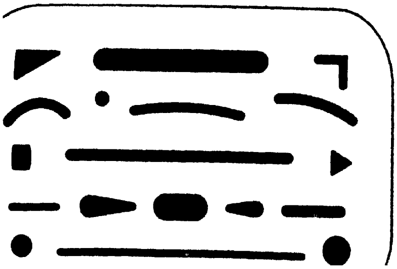
Draftsman's Tape and Thumbtacks. There are two ways of fastening the paper in place. The best way is to use four pieces of masking tape (draftsman's tape) across the corners. Fig. 3-10. The tape can be used over and over again and will not harm the board or bench. Some draftsmen still use thumbtacks. In time these will mar the surface of the board or table top, however.

Erasers. There are two common kinds of erasers, a red rubber or a yellow art gum. Fig. 3-11. These are used to correct mistakes and to remove light layout lines. The best kind is the red eraser. To erase lines, first clean the eraser on a piece of paper. Hold the paper firmly to the board and rub with short strokes. Brush the dirt away with a clean cloth or a brush. An eraser shield is very helpful. Fig. 3-12. Choose the correct opening and place it over the line to be erased. Hold the shield with one hand and rub across the opening with the eraser.

GETTING STARTED ON A SIMPLE DRAWING

1. Wipe the top of the table or

3-11. The red or ruby erasers and the art gum eraser.



3-12. An eraser shield can be used to help in erasing a line.

3-13. Laying out the correct length of line, using an architect's scale.

drawing board with a clean cloth. Also wipe each of the tools to be sure they have no dust or dirt on them. Wash your hands. Be careful after you sharpen pencils to keep the dirt off your fingers. You will find that neatness is important in drawing.

2. Choose a piece of paper 8½" x11" or cut one to size. Place the paper on the drawing surface with the long side vertical or horizontal.

3. Hold the T square quite low against the edge of the board. Place the paper against the upper edge. See that one edge of the paper is about 2" away from the edge of the board. Cut or tear off four pieces of masking tape. Place them across the corners so that about a half inch of each corner is covered. Fig. 3-10.

4. You are now ready to make a layout for your first drawing. To measure any length along a horizontal line, place the rule even (flush) with the upper edge of the blade. With a sharp pencil make a small light dot at the zero point on the rule and another at the correct length. Fig. 3-13. To measure for a vertical line, hold the rule against the edge of a triangle and do the same. To make a dot or mark, put the point of the pencil at the correct position and twist it slightly between your fingers.

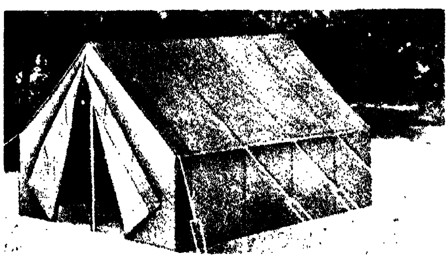
5. To draw a horizontal line, hold the pencil as shown in Fig. 3-6 or 3-7. Slide the T square up until the dots or marks are directly above the upper edge of the blade. Tilt the pencil so that the point is in the corner formed by blade and paper. Start at one dot and draw the pencil along from left to right, turning it slightly as you go. Apply even pressure. Slide the pencil hand along the T square with the little finger acting as a rest. Don't press so hard that a groove is made in the paper. This will make a very coarse line. Don't hold the pencil so lightly that the line is difficult to see. You want a nice, clean, sharp line that is easy to read. Start and stop exactly at the ends of the lines. Turning the pencil will keep the point sharp longer.

6. To draw a vertical line, hold the triangle against the T square with the edge directly over the dots. Draw the line from the bottom dot upward in the same way. Fig. 3-9. Be sure to hold the T square and triangle firmly in place. If you don't, the triangle may slide or the T square may tip slightly.

Section I

4. Drawing Inclined (Slanted) Lines and Angles

You have already used a triangle to draw vertical lines. Now let's look at these tools again and see how they can be used in other ways.



4-1. How many triangles can you see in this tent (and tent ropes)?

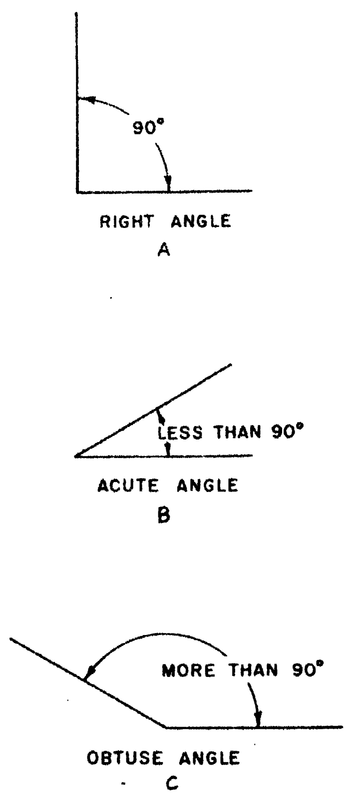
TRIANGLES

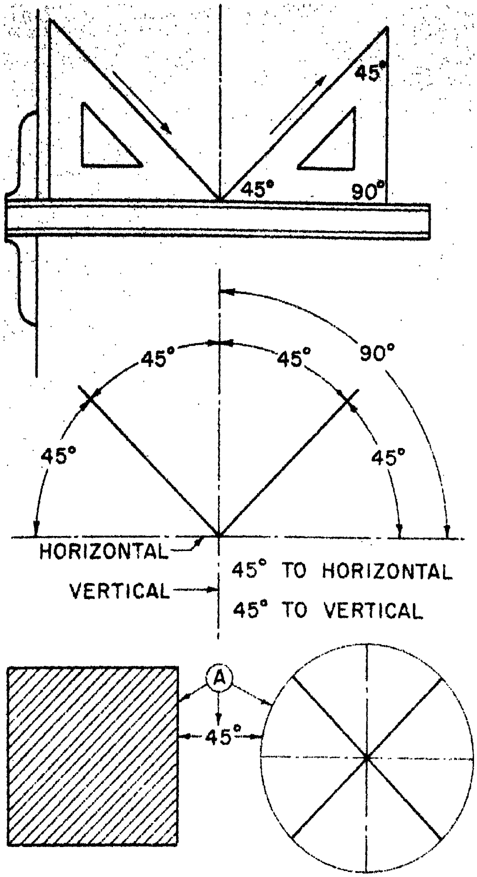
A triangle is a three-sided figure. Fig. 4-1. The two you use in drawing are the 45 degree and the 30-60 degree triangles. The 45 degree triangle has one right angle (90 degrees) and two that are 45 degrees making a total of 180 degrees. The 30-60 degree triangle also has one right angle, one that is 30 degrees and a third that is 60 degrees.

KINDS OF ANGLES

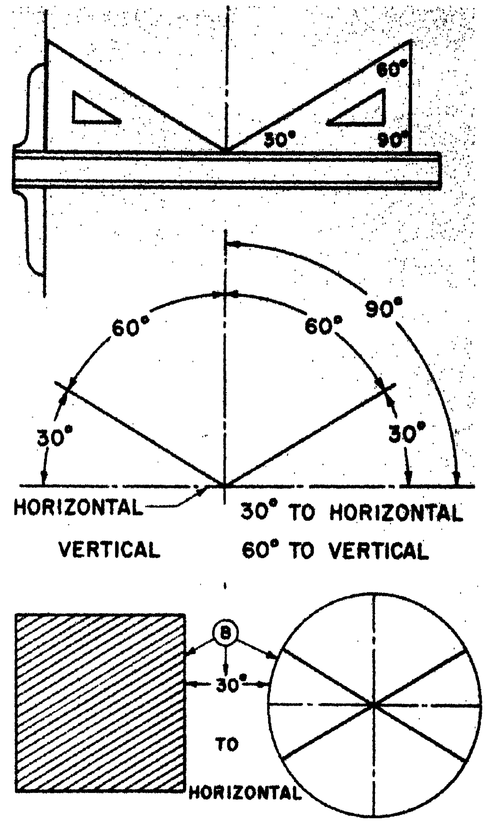
If an angle is less than 90 degrees it is an *acute* angle. Fig. 4-2B. If it is exactly 90 degrees it is a *right* angle. Fig. 4-2A. When it is more than 90

4-2. Kinds of angles (A) right (B) acute, (C) obtuse.





4-3. Drawing lines at an angle of 45 degrees. Note the arrow showing the direction for drawing the lines. The square and the circle show lines at an angle of 45 degrees.

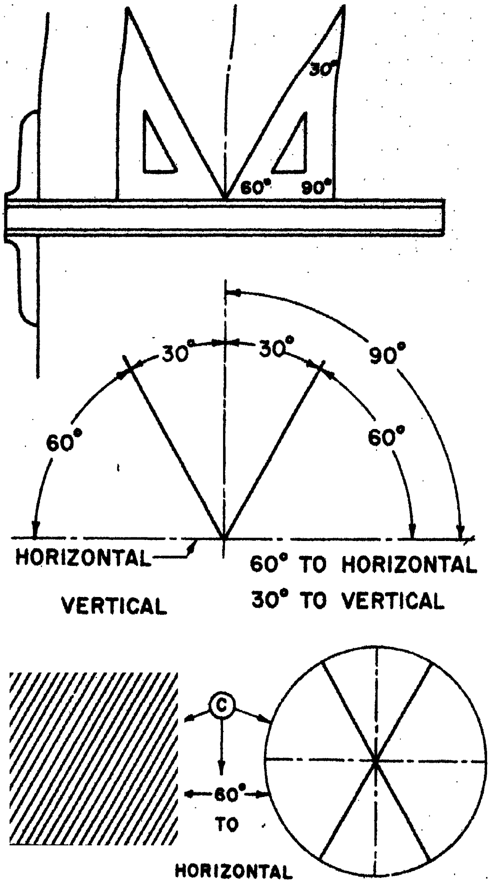


4-4. Drawing lines at an angle of 30 degrees to the horizo

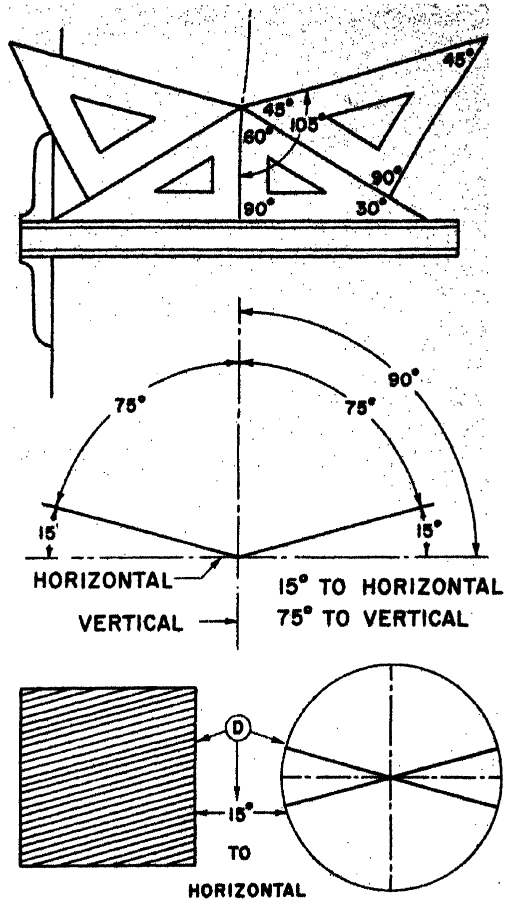
degrees it is an *obtuse* angle. Fig. 4-2C.

DRAWING ANGLES

You can use your triangles to draw lines at various angles to the horizontal and vertical line. To draw a 45 degree angle, place the 45 degree triangle against the upper edge of the T square. Hold the two tools firmly to the paper with one hand and draw the line as shown in Fig. 4-3. The direction in which the line is drawn is shown with an arrow. Notice that the line will be at an angle of 45 degrees to both horizontal and vertical. In Fig. 4-4, the 30-60 degree triangle is used to draw a line at 30 degrees to the horizontal and 60 degrees to the vertical. By using this triangle in the other position, Fig. 4-5, these angles can be reversed. By using the two triangles together as shown in Fig. 4-6 and Fig. 4-7, you can obtain angles of 15 and 75 degrees. Fig. 4-8 shows a circle divided into 15



4-5. Drawing lines at an angle of 60 degrees to the horizontal.



4-6. Drawing lines at an angle of 15 degrees to the horizontal. Notice how the two triangles are used together to do this.

degree segments. (The triangles were used in the different positions shown in Fig. 4-3 to Fig. 4-7. With a little practice you will find it easy to use the triangles in every position). Fig. 4-9 shows how to use the 30-60 degree triangle to lay out a clock face.

DRAWING PARALLEL LINES

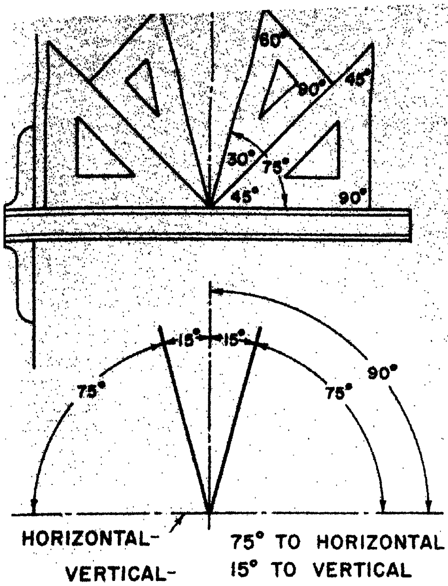
To draw a line parallel to another line, place one edge of the triangle in line with the first line. Fig. 4-10. As a guide, slide the T square up to the triangle. Then slip the triangle along and draw the second line.

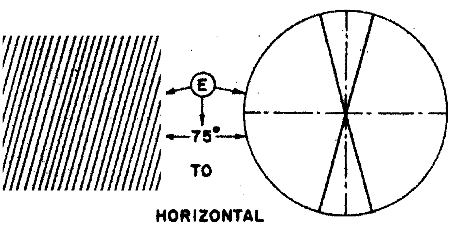
DRAWING PERPENDICULAR LINES

To draw a line perpendicular to another line, hold the triangle against the T square as shown in Fig. 4-11. Draw the first line. Now slide the triangle over and draw the second line to intersect the first.

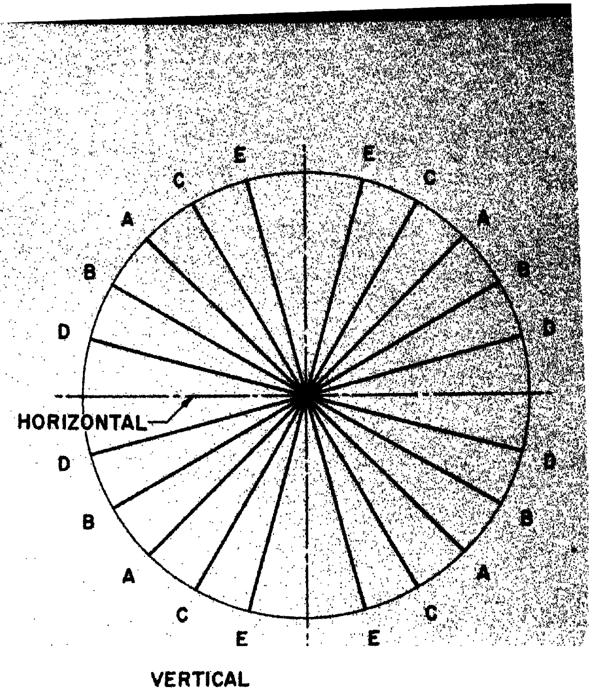
PROTRACTOR

A protractor is a drawing tool made of metal or plastic and shaped like a half circle. Fig. 4-12. It is used to lay out odd angles (those other than





4-7. Drawing a line at an angle
grees to the horizontal. See
two triangles are used.

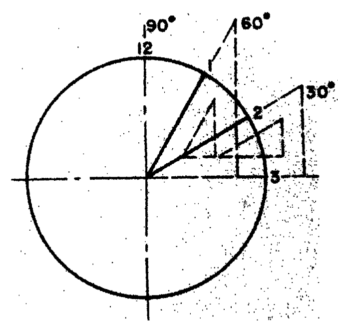


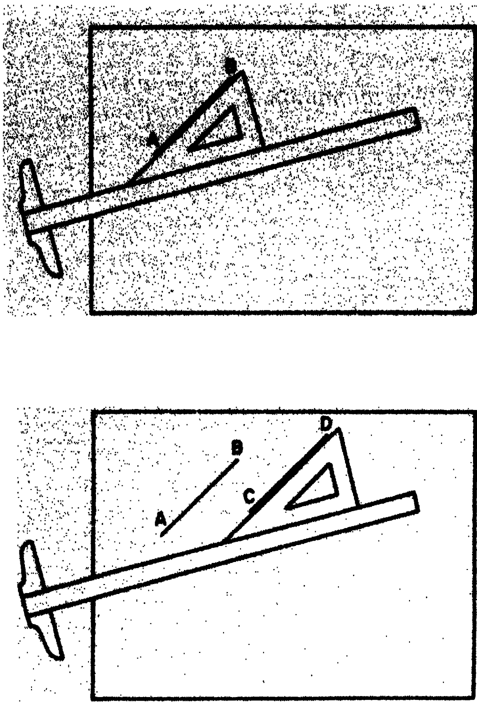
4-8. A circle divided into 15 degree segments. Each letter around the circle is the same as the line shown by the letters in Figs. 4-2 to 4-7. For example, B is a line drawn at an angle of 30 degrees to the horizontal, as shown in Fig. 4-4.

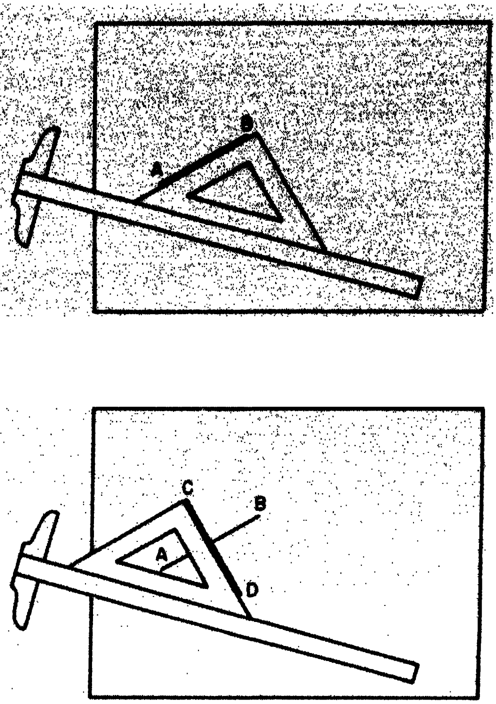
multiples of 15). The scale on the outer edge is divided into degrees running from 0 to 180 from *left to right*. The scale just inside that runs from 0 to 180 degrees from *right to left*. The outer scale is used to draw angles that run from left to right.

To lay out an angle, draw a horizontal or vertical line. Place the straight edge of the protractor on the line. The center of the protractor should be at a point marked on the line where the angle is to be drawn. Find the correct angle on the scale

4-9. Using a 30-60 degree triangle to lay out the position of a clock face.



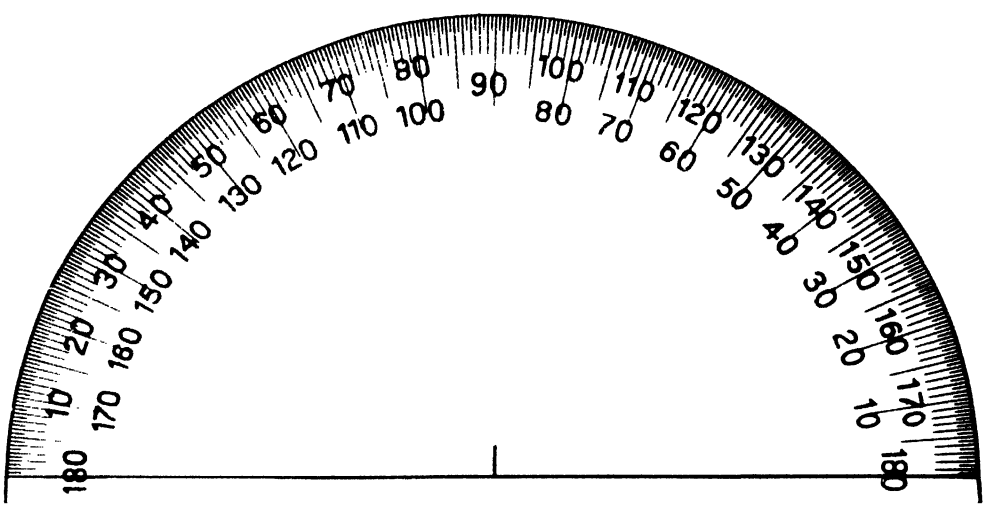


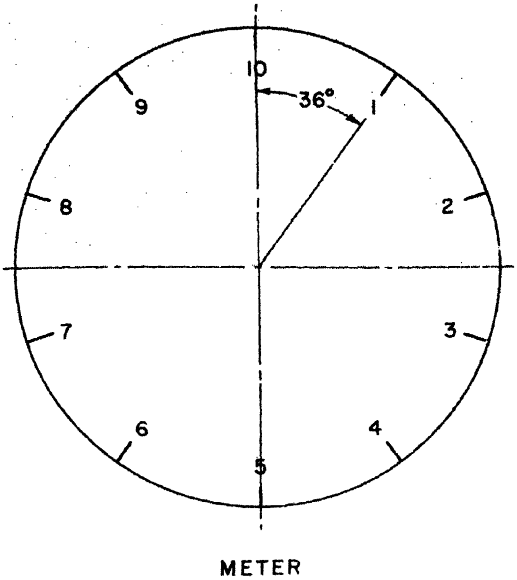


4-10. Drawing parallel lines. (Left-handed person—reverse sides.) AB is drawn first. Then the triangle is slid along the T square and line CD drawn.

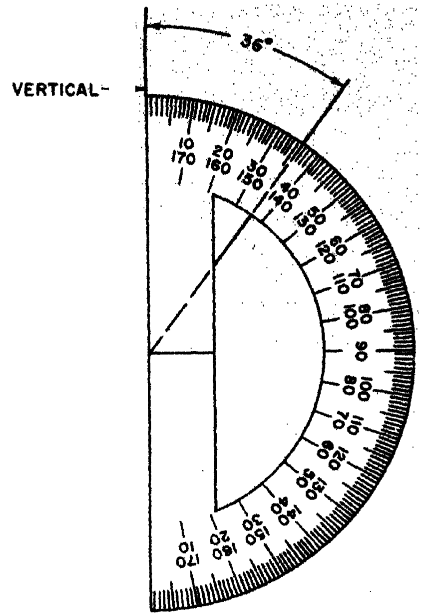
4-11. Drawing lines at right angles to each other. (Left-handed person—reverse sides.) AB is drawn first, then the 45 degree triangle slid to the left and line CD drawn.

4-12. A protractor. Notice how the outside scale is from zero on the left to 180 degrees on the right. The inside scale is exactly the opposite.





4-13. An electrical meter face must be divided into segments of 36 degrees, or 10 equal parts, in a 360-degree circle.



ing a protractor to lay out a 36-
° angle.

and mark a point. Now use a straightedge instrument to finish the angle.

To illustrate, suppose you wish to lay out an electric meter face. This meter has ten divisions around the circle. Therefore each division must be 36 degrees. Fig. 4-13. Place the protractor with the edge in line with the vertical line. Mark 36 degrees, then 72 degrees, etc., to complete half the meter face. Fig. 4-14. Reverse the tool and mark the other positions. Use a rule or straightedge to draw the line to form the angle.

Section I

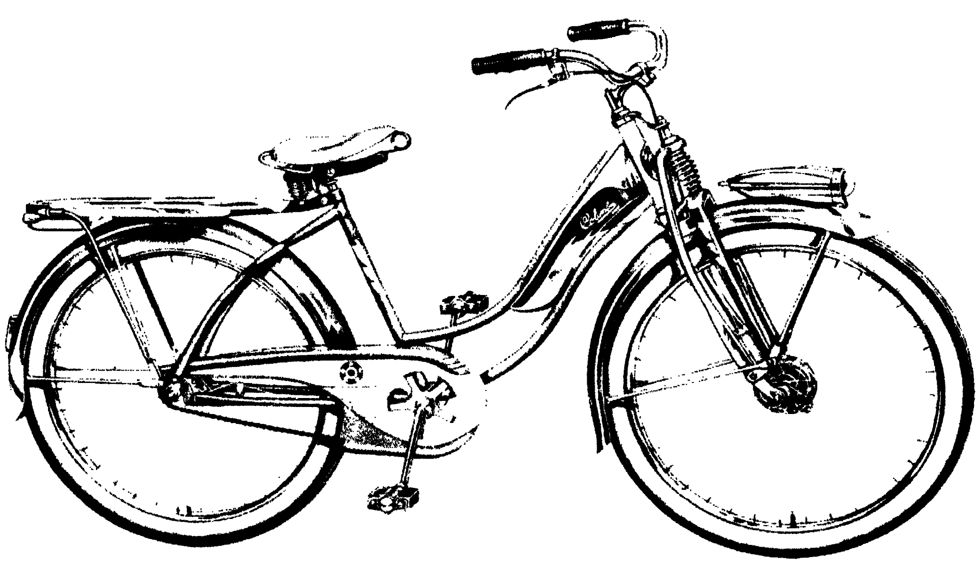
5. Drawing Circles, Arcs, and Irregular Curves

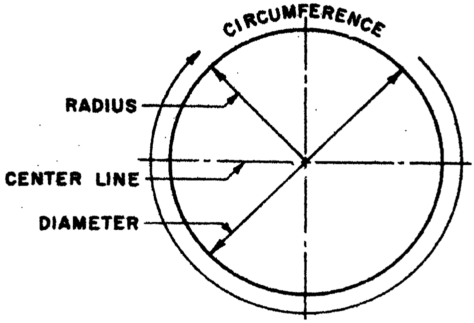
It's often been said that the wheel is man's greatest invention. Without it you wouldn't have bicycles, cars, trains, or anything mechanical. Fig. 5-1. Can you name some more of these? The wheel is only one item that is drawn in the shape of a circle.

A circle, then, is a ring-shaped object. Round holes and other cylindrical shapes are also drawn as circles. The *diameter* of a circle is the length of a straight line through the center. The *radius* is half the diameter. The *circumference* is the distance around the outside. Fig. 5-2. An *arc* is a part of a circle. A line is *tangent* to a circle when it touches the outside but does not cross it. Fig. 5-3.

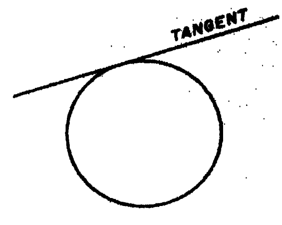
Circles are usually drawn with a compass.

5-1. How many circular parts can you count on this girl-style bicycle?





5-2. The parts of a circle.



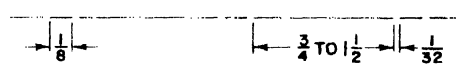
5-3. A line tangent to a circle.

KINDS OF COMPASSES

On all compasses one leg is a metal point. There are several kinds. The simplest is a *pencil compass*. The second leg has an opening for a pencil. Fig. 5-6. Use an H or 2H pencil, sharpened to a cone-shaped point, on a pencil compass. On a *drawing compass* a piece of lead fits into the second leg. Sharpen this point to a wedge shape. See Unit 1 of Section III. Adjust the compass so that the metal point is about 1/32" longer than the lead point.

LOCATING THE CENTER OF CIRCLES

Before drawing a circle, draw two intersection lines to form the center. These lines are made up of a long dash, a space, a short dash, a space, and a long dash, as shown in Fig. 5-4. This is called a *center line*. The center line is used to locate the center of all circles and arcs and to divide an object that is equal on both sides (symmetrical). (On small circles or arcs, only two small dashes are used.



5-4. The correct way of drawing a center line. This is drawn as a fine, light line.

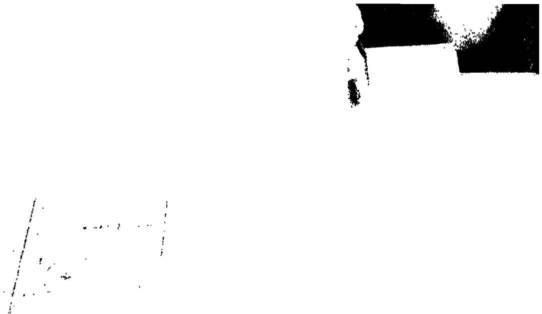
ADJUSTING THE COMPASS

Place a rule or scale on a piece of scrap paper. Never place the point of the compass on the rule itself. Fig. 5-5. Hold the point of the compass at the zero mark of the rule. Next open the compass until the measurement shows the correct radius. Then test the compass by turning a small arc on scrap paper. Measure from the center to the arc to check the radius.

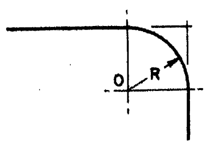
DRAWING CIRCLES

Place the point of the compass over the center of the circle. Hold the top of the compass between the thumb, forefinger, and third finger. Tip the compass slightly toward yourself and turn it clockwise. Fig. 5-6. (Left-handed persons—counter-clockwise.)

5-5. Adjusting one type of compass. (Left-handed persons—reverse.)

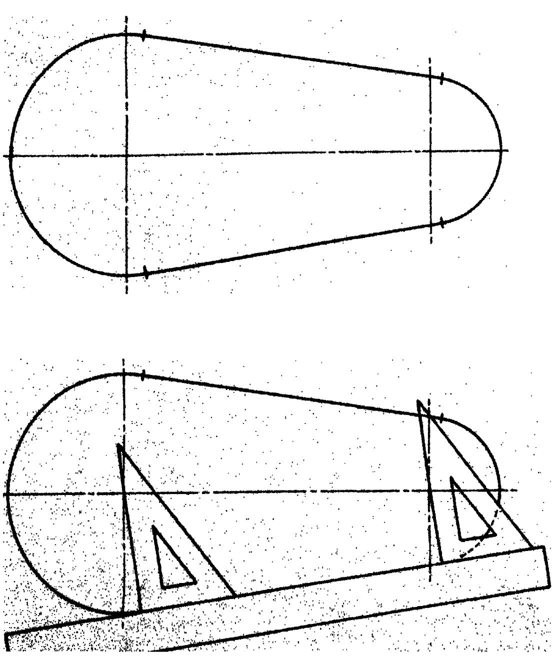


5-6. Using a pencil compass.



5-7. An arc to form a rounded corner.

5-8. Notice how the point of tangency is located with a straightedge and triangles.



Apply just enough pressure all the time to make a clear, sharp line. If you apply too much pressure the legs may spread, ruining the circle. Don't go over the line too often. Make sure that the line made by your compass looks the same in thickness as other straight lines drawn with a pencil.

DRAWING ARCS

An arc is often used as a part of a drawing to show a round corner. The arc is tangent to two lines at 90 degrees. To draw this preceed as follows:

1. Draw very light construction lines to represent the straight lines that intersect.

2. Measure in from these lines an amount equal to the radius of the arc. Draw two lines that are parallel to the first lines to locate the center for the arc. (0).

3. Adjust the compass to the correct radius, using 0 as the center. Draw the arc from one straight line to the next. Try to make a sharp, clean curve. Fig. 5-7.

4. Go over the straight lines again with a pencil to darken them, if necessary. The line of the arc and the

straight line should appear to be the same weight. Also, make sure the straight line joins the arc without overlapping.

To draw a figure in which arcs of two different radii (more than one radius) are joined with straight lines, proceed as follows (Fig. 5-8.):

1. Draw the arcs at either end, using a light line.

2. Place a straightedge or rule just touching the circumference of both

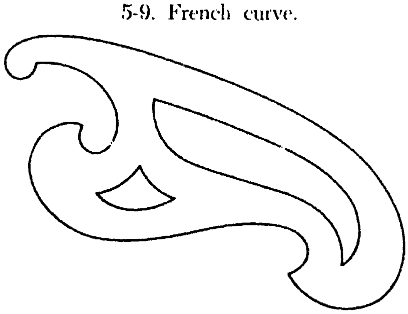
3. Hold a triangle against this straightedge. Slide it along until the right angle made with the straightedge passes through the center of the arc. Mark this position on the circumference. This is the point of tangency. Do this on both sides of both arcs.

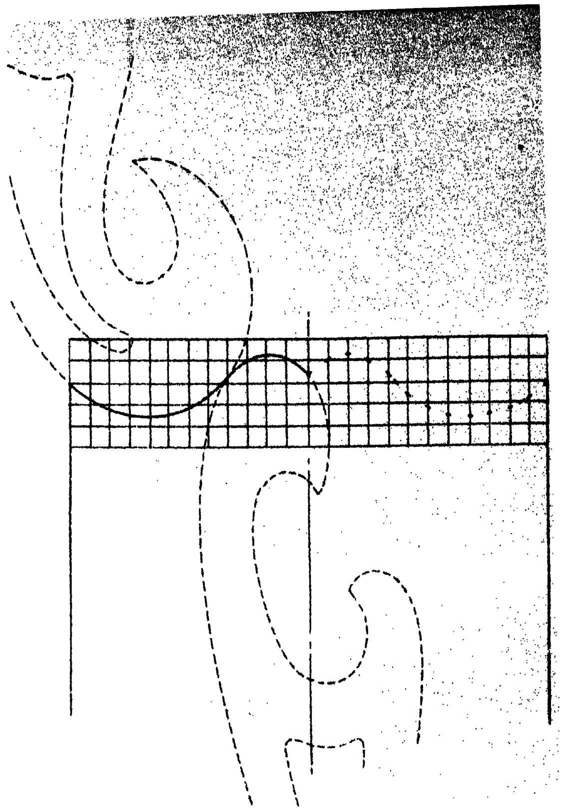
4. Darken the arcs. Then draw the straight lines connecting the points of tangency.

DRAWING IRREGULAR CURVES

Many projects have irregular curves, especially those in metal and wood. To draw these use a French, or irregular, curve. This is a plastic device made in several shapes and sizes. Fig. 5-9. Different places on the curve duplicate different curved shapes. To draw an irregular curve, first locate the several points that the curve is to follow. The more points the better. It is a good idea to sketch a freehand curve that roughly follows those points. Now, use the French curve. By trial and error *move the curve until three points are in contact with it.* Fig. 5-10. Draw this curved section not quite up to the outside points. Move the curve to the next three points and repeat. You will need to slide the device around each time to find the proper curvature.

5-9. French curve.





5-10. Using a French curve.

Section I

6. Completing a One-View (Layout) Drawing

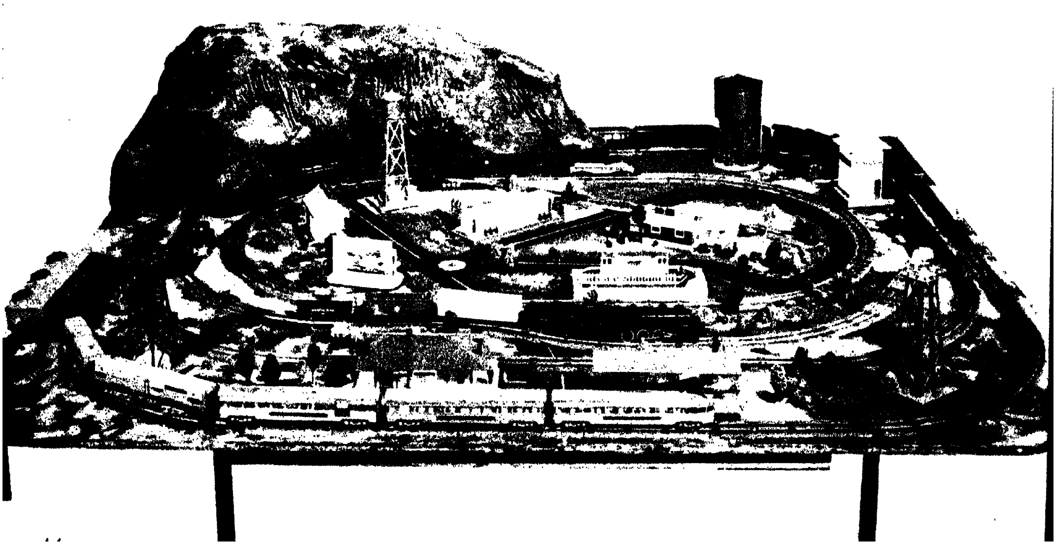
Many of the drawings that you make and use in the shop and in everyday life need only one view. Figs. 6-1 and 6-2. For example, only one view is needed as a layout for a ball field, the design for book ends, or a pattern. Figs. 6-3 and 6-4. Drawings in electricity, home planning, and weaving also require only one view. Fig. 6-5. Here is the way to make a one-view drawing. Fig. 6-6. You will find that other drawings are made in about the same way.

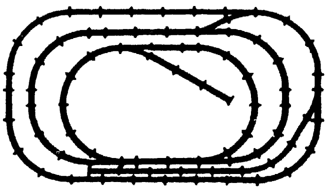
1. Draw a border on the sheet. A border is placed on a drawing to improve its appearance. It's like putting a frame on a picture. Then, too, the border says, "Everything inside these lines is important. Study it carefully." The small area beyond the border can be used to bind several drawings together.

To lay out a border proceed as follows:

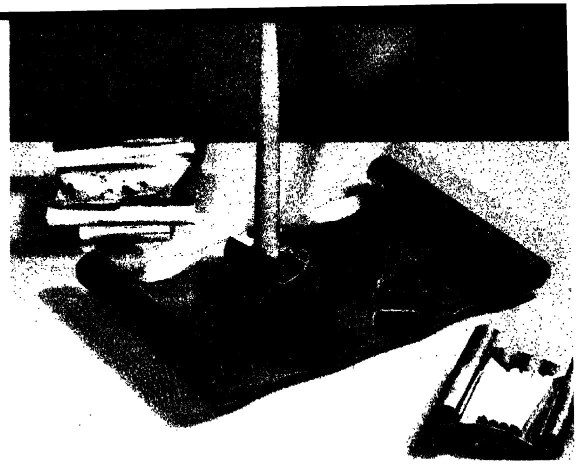
a. Choose a piece of 8½" x 11" paper. Locate the paper on the drawing board in a horizontal position. Hold the rule against the upper edge of the T square. Measure in ¼" from the left edge of the paper. Make a

6-1. Model train.





6-2. A one-view (layout) drawing for a model train track similar to the one in Fig. 6-1.



6-3. Some art-metal objects that require only a one-view drawing.

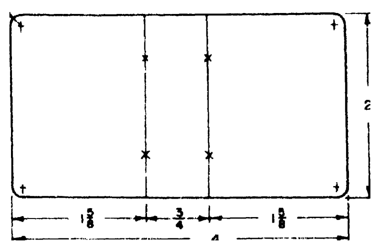
dot or small dash. Then, 10½″ from this mark, place another small dot.

b. Draw two light vertical *construction* lines the total height of the paper. These are very light lines which show the location and approximate length of the permanent lines. Use a 3H or 4H pencil or press very lightly with your 2H pencil.

c. Hold the rule against a triangle in a vertical position. Measure up ¼″ from the bottom of the paper. From this point measure 8″ and make a second dot or mark.

d. Draw two light horizontal lines to form the border. Don't worry if the corners cross.

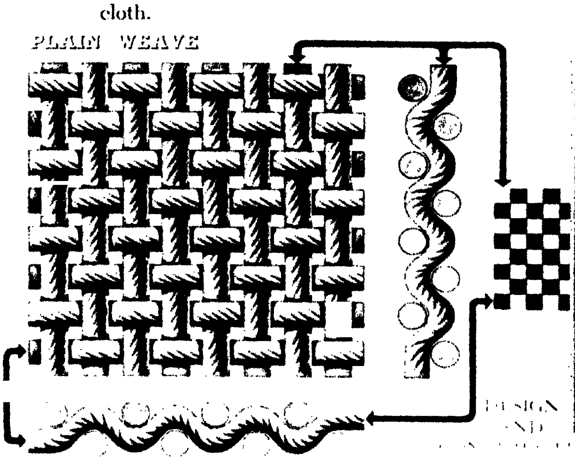
2. Draw a title block or record strip. Certain information about what the drawing is and who made it must be given on each drawing. This is placed in the *title block* or *record strip*. School drawings usually give the name and location of the school, the name of the object, the scale, the student's name, and the number of the drawing. Often there is a place for the instructor to okay the work.

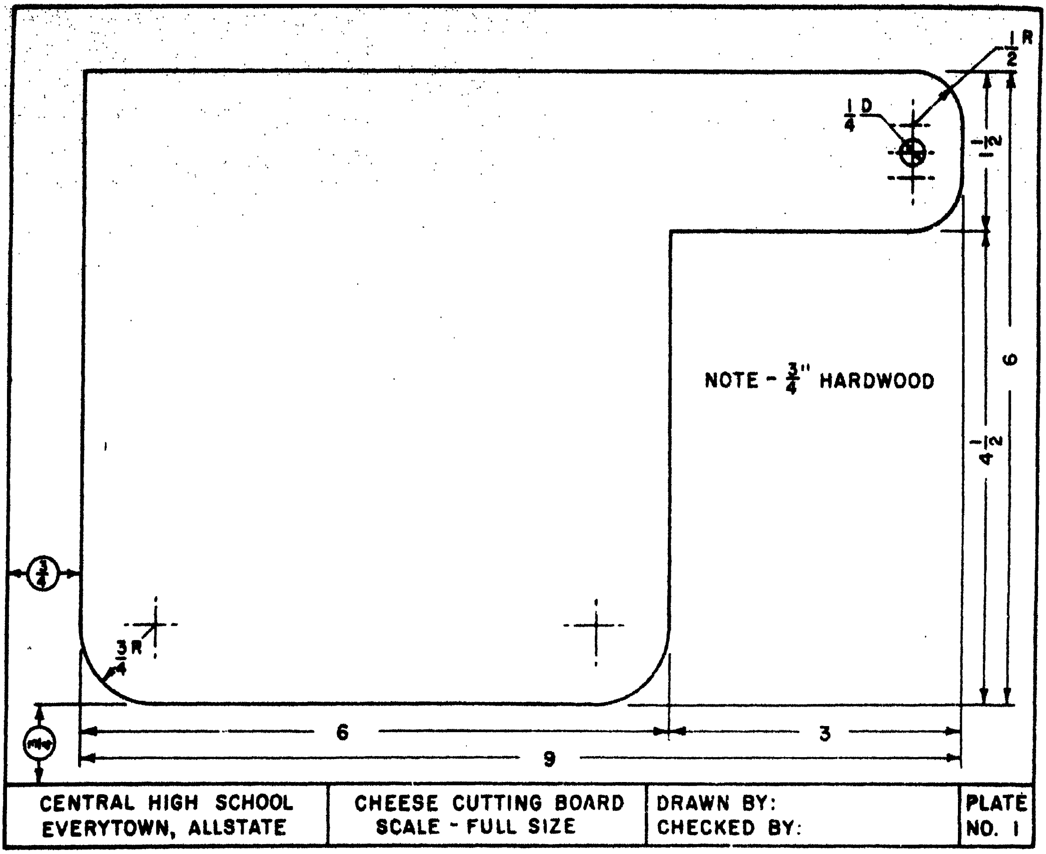


6-4. A one-view drawing of the match box cover shown in Fig. 6-3.

The title block or strip can be drawn in the lower right-hand corner, along the bottom, or along the right side. Fig. 6-7. Let's place this title block across the bottom. Measure up

6-5. A one-view drawing of plain weave in cloth.





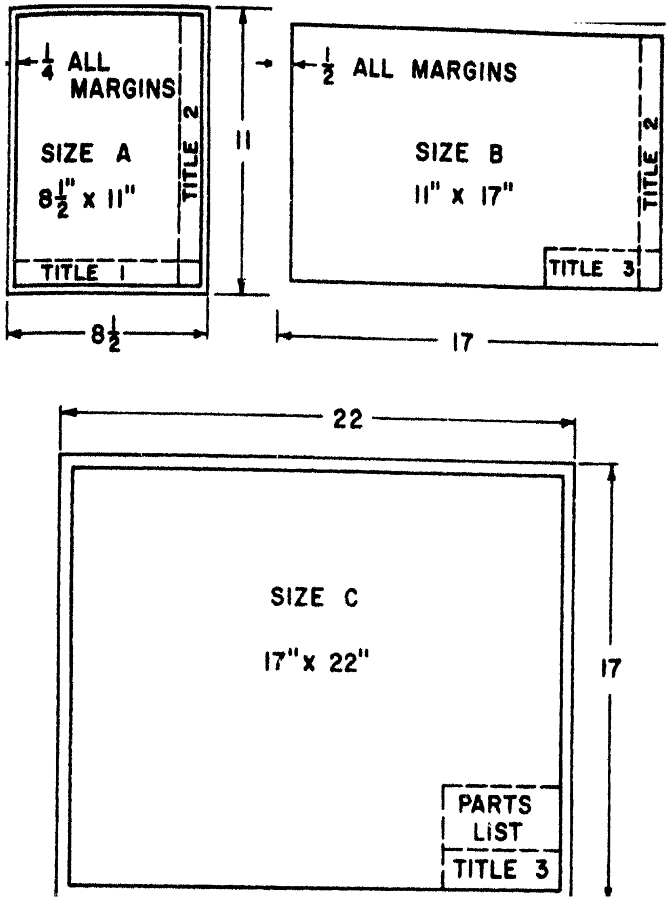
6-6. A complete one-view drawing of a cheese-cutting board. The dimensions shown in the circle will help you to center the drawing. Don't put these on if you draw it. The title block, or record strip, at the bottom, is ⅝" wide.

from the border line ⅝" and draw a heavy line across the paper. Divide this space into five equal parts vertically. Draw five light guide lines across the page. Divide the area horizontally into three parts 3¼" wide and one part ¾" wide. The title block or strip may be drawn in several other different ways. Fig. 6-8.

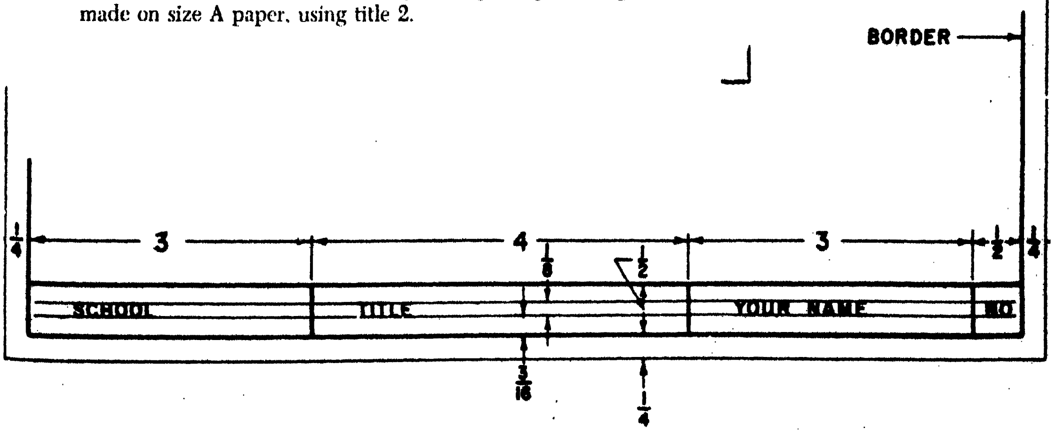
3. Center the drawing. All drawings are centered on the paper to improve the appearance of the finished drawing. To center the cheeseboard proceed as follows:

a. Measure the length of the board (9"). Subtract this from the horizontal distance inside the border lines (10½"). Divide this amount (1½") in half. Measure in from the left edge this distance (¾") and draw a light vertical line.

b. Measure the width of the board (6"). Subtract this from the vertical distance between the upper border line and the title strip (7⅜"). Divide this amount (1⅜") in half. To make the drawing appear on center use ¾" instead of   Measure up from



6-7. The common sizes of paper and the location of the title block, or record strip, on each. Most of your beginning drawings will be made on size A paper, using title 2.



6-8. Another simple title block, or record strip, to use on 8½" x 11" paper. Note the difference between this one and that shown in Fig. 6-6.

the border line a distance of ¾″ and draw a light horizontal line. These are the two reference lines from which all other measurements are made.

4. Complete the layout. Lay out a distance of 9″ along the horizontal line and 6″ along the vertical line. Draw these two light construction lines to "block in" the over-all size. Measure a distance of 6″ from the left edge of the object. Draw another vertical line. Measure up a distance of 4½″ and draw a horizontal line. You now see the approximate shape of the board. Locate the centers for the arcs to complete the round corners. Locate the position for the hole for hanging up the board. Draw the arcs and circle with a compass.

Darken the straight lines to complete the view, using an H or 2H pencil. These are called *object* or *visible* lines. Use an H or HB pencil to darken the border lines. Form sharp corners that do not overlap. Erase the construction lines beyond the corners. The *border* lines should be the heaviest on the page. These lines are usually darkened in last so they won't smudge as you work on the drawing.

Erase the construction lines beyond the object or outline lines. Read units 7 and 8 before completing steps 5 and 6.

5. Dimension the drawing. The drawing must give dimensions, or sizes, so that the object can be made in the shop. To add these dimensions you will learn to make two new kinds of lines. Lines that extend out from the object are called *extension* lines. These are light solid lines that start about   away from the *object* or *visible* lines. Draw these lines below and to the right of the object. The length of these lines will vary with the number of dimensions you must add to the drawing. The lines that go between these *extension* lines are called *dimension* lines. These are light, solid lines with a space in the middle and arrowheads on one or both ends. These should be placed about ⅜″ to ½″ away from the outline of the object.

6. Letter in the dimensions and information in the title block. Place the dimensions on this drawing so they can be read from the bottom and the right side. Letter in the necessary information in the title block or record strip. Add the note on the drawing which tells the kind and thickness of wood to use.

Section I

7. Learning to Letter

Have you ever gone to a courthouse to get a license for your dog? Or have you seen forms for entering a contest? If so, you know that most forms say "Please Print" in the spaces asking for your name, street address, city, and state. What they really want is for you to "letter" in this information, rather than to write it. The reason, of course, is simply that it is much easier to read lettering and there is less chance for error. It's exactly for this reason that you want to put notes, dimensions, and other information on your drawings by lettering.

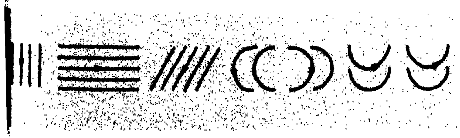
WHAT IS LETTERING?

Lettering is really a kind of *freehand drawing* for forming the letters of the alphabet and numbers. Many of you might say, "But I already know how to print," while others will say, "I don't think I could ever learn to letter very well." Actually, both are wrong. You may be lettering the wrong way, yet doing good lettering requires only patience and practice. Anyone can learn to letter if he can make these four lines well: horizontal, vertical, slant, and curved. Fig 7-1. This is because all letters are made up of these four lines in some combination. For example, an L is a single vertical line and a single horizontal line. A U is two vertical lines and a short curved line.

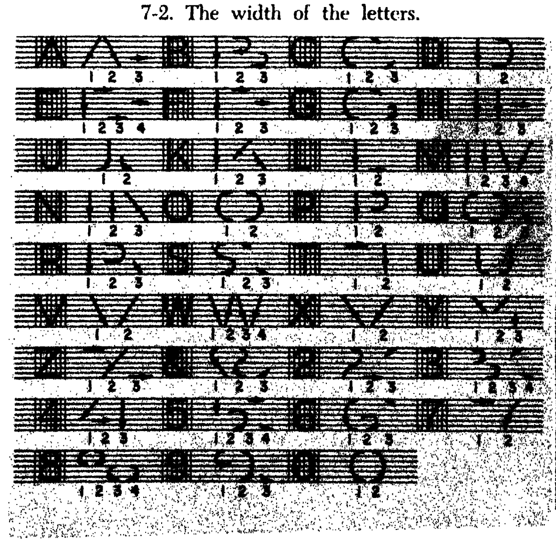
KINDS OF LETTERING

The lettering you will learn to do is called *single stroke Gothic*. That means it is a simple form of letters made with *single strokes* of the pencil.

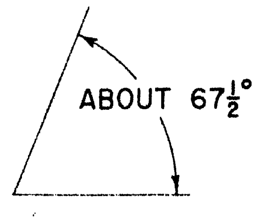
7-1. Four practice strokes you need to learn to do good lettering. The arrows show the direction for making the lines.



7-2. The width of the letters.



7-3. Inclined lettering.



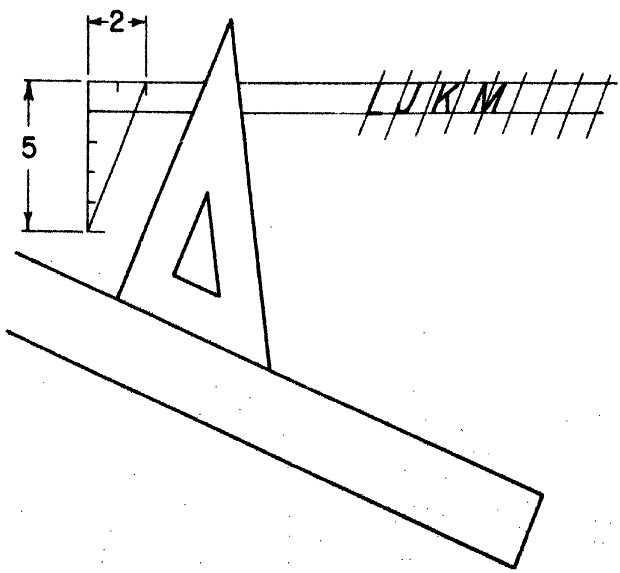
7-4. The angle at which inclined lettering is done.

Look at an alphabet of capital letters. Notice that all letters are not the same width. Imagine that a letter is to be made in a little box divided into six spaces wide and six spaces high. This would be the widths of some letters: C=5 spaces wide; M=6 spaces wide; I= only one space wide. Look at the width of the other letters. Fig. 7-2.

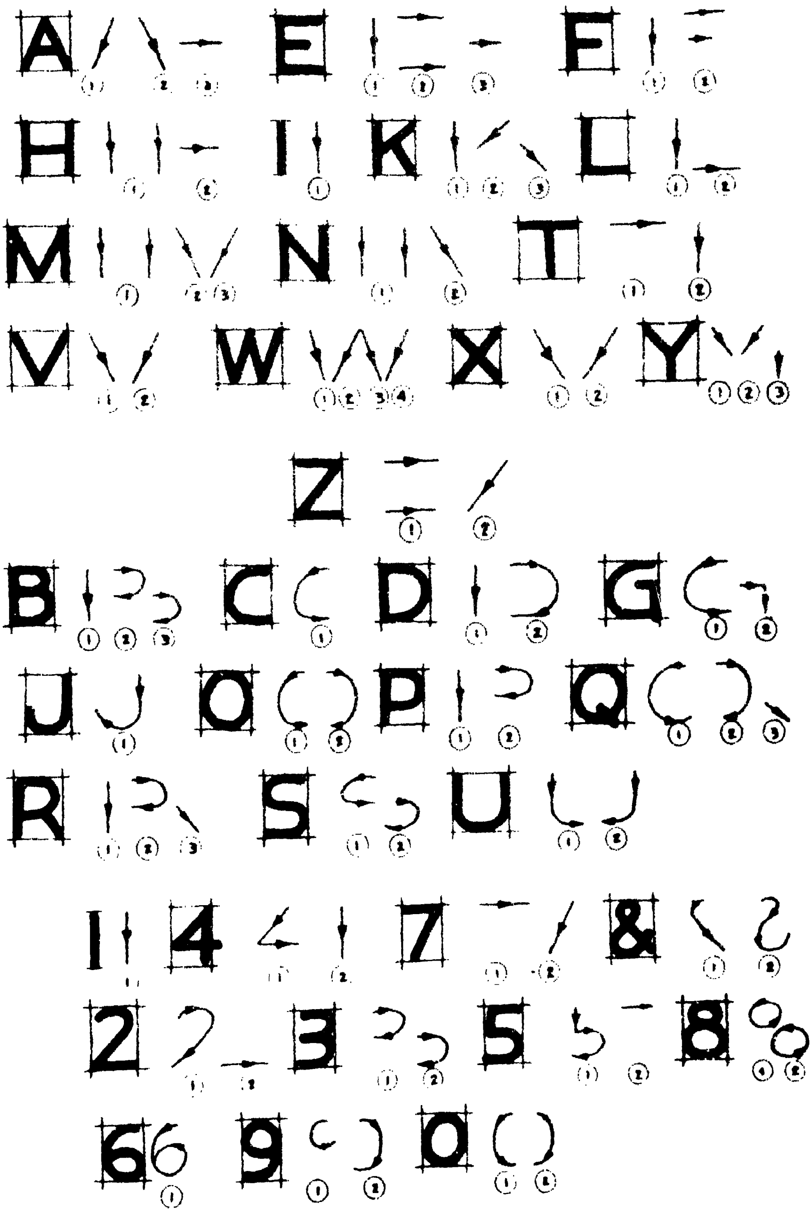
In beginning drawing, a simpler way is to make all the letters the same width except three. The J is a little narrower than the others, the I is just one line wide, and the W is a little wider than most. That's easier to remember.

Lettering that is done with all the letters at right angles to the hor-

7-5. A simple mechanical way of getting the correct angle for inclined lettering.



• LETTERING WITH THE RIGHT HAND •



7-6. The correct way to form the letters if you are right handed.

7-7. The correct way of lettering if you are left handed.

izontal is called *vertical* lettering. Lettering is also done with the letters forming an angle of about 67½ degrees, Fig 7-3, to the horizontal. This is called *inclined* lettering. Figs. 7-4 and 7-5.

Now let's look at the alphabet to see how the letters are drawn. Notice that E, F, H, I, L, and T combine vertical and horizontal lines only. The A, K, M, N, V, W, X, Y, and Z are made up of vertical, horizontal, and or inclined lines. The remaining letters combine all these, plus the curve. Notice also, in Figs. 7-2, 7-3, 7-6, and 7-7, the arrows and numbers beside each letter. This suggests a way you can make each stroke to form the letters. The charts Figs. 7-6 and 7-7, show both right- and left-handed people how to do this.

LETTERING PRACTICE

Now let's try to do some lettering. First, always use guidelines to keep the work straight. You should use a guideline even when you have a single dimension to put on a drawing so that the numbers look uniform in size. On most drawings letters are made about ⅛″ to 3/16″ high. The size, of course, varies with the over-all size of the drawing. It's easier to form smaller letters than larger ones. Lay out light, horizontal guidelines on your paper. These can remain on the drawing. Now select an H or 2H pencil for lettering. Be sure it is sharp. Sit or stand in a relaxed position. Hold the pencil lightly but firmly in your hand. The reason many people never learn to do good lettering is that they tense up too much as they work the lines. Relax and take it easy. Rest your elbow on the drawing bench for firm, easy support.

Practicing Strokes. Try some vertical strokes, some horizontal strokes, some slant strokes, and some curved strokes. Fig. 7-1. Can you make these a uniform length, the lines straight, the curves smooth and always the same angle? After you have done this exercise for a little while begin to form the letters. The A has a horizontal line about one third of the way up. All the rest of the letters are divided about (but slightly above) center. The bottom of the letter should be a little larger than the top so it looks stable. Form all the *same shaped* letters at one time —that is, all the vertical and horizontal letters and then go on to try others.

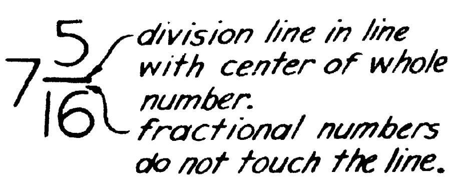
Making the O. Many of you will find that your poorest letters are those with curved lines. These are more difficult to make freehand. The O is the basic letter in this group. Make several of them until you get a feel for the circular motion. Don't be discouraged with your early lettering. It will not be as even as you'd like it to be. It takes practice.

Numbers. After doing capital letters, try numbers. These are made in the same general way. When lettering fractions, make the over-all fraction about two times the height of a whole number. For example, do it as in Fig. 7-8 and 7-9.

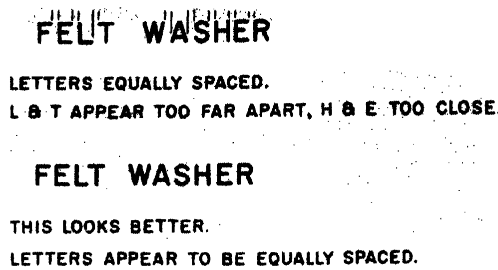
Words and Phrases. After you have learned to make each letter you are ready to form them into words and phrases. If you space all of your letters an equal distance apart, some appear farther apart than others. For example, an I that follows an L would appear much farther away than a D that follows an M. This is because the first two have a lot of white space around them and are *open* letters, and the other two have little or no space around them and are *closed* letters. Therefore, in forming words, place the open letters closer together than the closed letters. This will make the words appear to be uniformly spaced. Fig. 7-10.

When lettering a sentence, leave a space between words equal to the width of the average letter. The space between sentences should equal twice the height of the letters. The space between lines of words should be about equal to the width of the letters. Fig. 7-11.

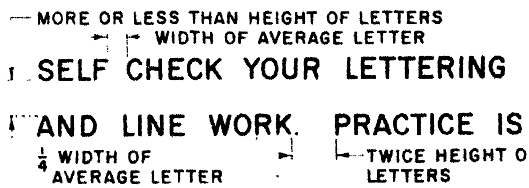
7-8. The correct height of fractional numbers.



7-9. The correct method of drawing fractional numbers.



7-10. The incorrect and correct spacing of letters to form words. Use your eye to judge the spacing.



7-11. Spacing in lettering.

Importance of Lettering. Lettering is something you will continue to use. Try to show improvement all the time. Develop good lettering practices and stick to them. It will help with your grades and give your work a snappy appearance that will please you and all who see it. In fact, you might be surprised how much you can gain by applying this rule to *all subjects.* Good well planned papers, with neat lettering or handwriting, makes a great impression on any instructor and make you do a better all-around job as well, because a sloppy-looking paper or drawing is hard to keep free of errors.

Section I

8. Dimensioning a Drawing

To be completely useful a drawing must show the shape of the object, its size, and other information necessary to construct it. The shape is shown by lines. Fig. 8-1. Dimensions tell the size or the measurements. Other information about the kind of material to use, number of pieces, and the like is added in the *title block* or *record strip* or is put on as a *note*.

GENERAL RULES FOR DIMENSIONING

1. Put on the dimensions so they are easy and convenient to read.

2. Show only the measurements you need to build the object. Nothing more. *These rules (1 and 2) are the most important to follow in all drawing.*

3. Do not duplicate or repeat dimensions. This just clutters up the drawing.

4. Use these three (some say two—*size* and *location*) kinds of dimensions: Fig. 8-2.

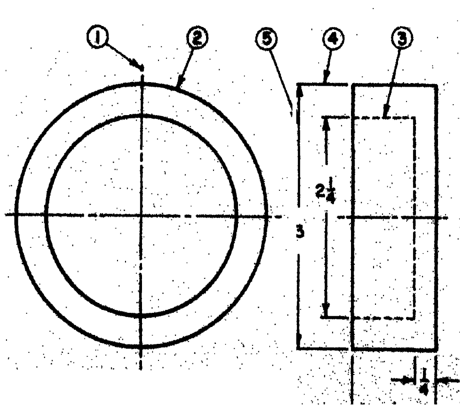
   a. Over-all (size) dimensions that show the total height, width, and length of the object.

   b. Detail (size) dimensions that show the measurement of important details. The *diameter of a hole* is a good example.

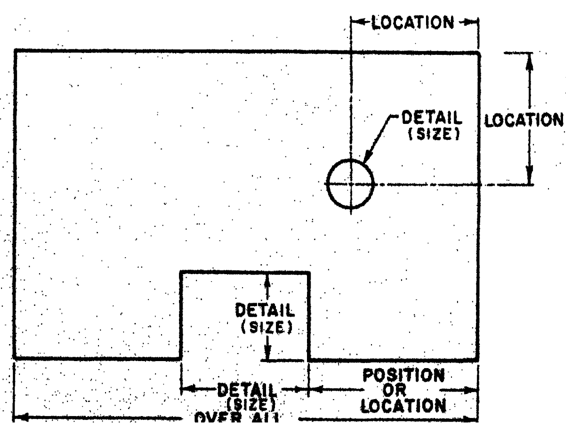
   c. Location, or position, dimensions that show where the details

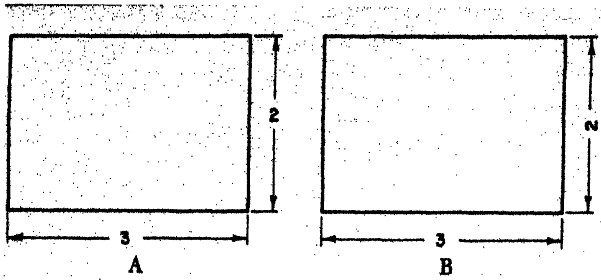
5. Place the dimensions on the drawing in one of two ways. Both

8-1. The correct method of drawing lines: 1. Center line. 2. Object, or outline, line. 3. Invisible, or hidden, line. 4. Extension line. 5. Dimension line.

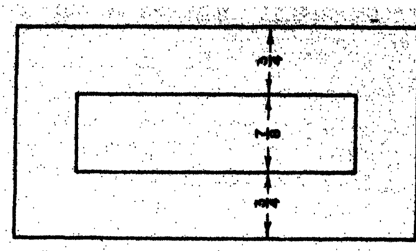


8-2. The three kinds of dimensions.

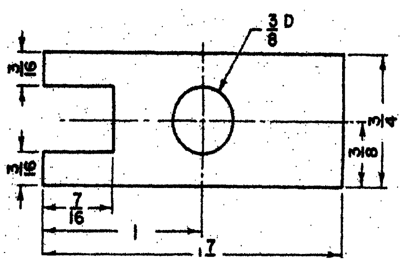


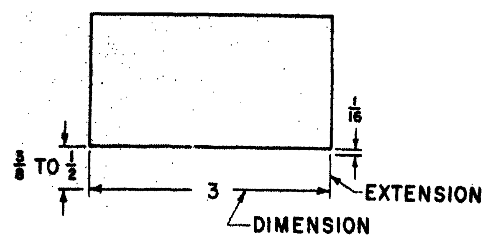


8-3. The two methods of placing dimensions. A. The one direction (unidirectional) method of dimensioning—all figures made straight up and down. B. The two direction (aligned) system of dimensioning—read from the bottom and right-hand edge of the paper. You have to turn the drawing to read side figures.



8-4. Notice that it's easier to read these dimensions when they are placed inside the drawing. If possible, however, keep the dimensions off the view.



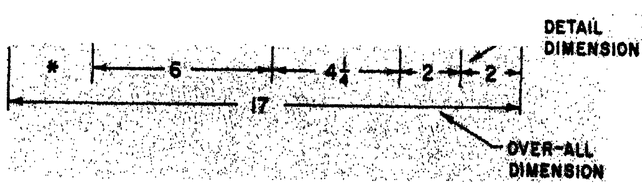


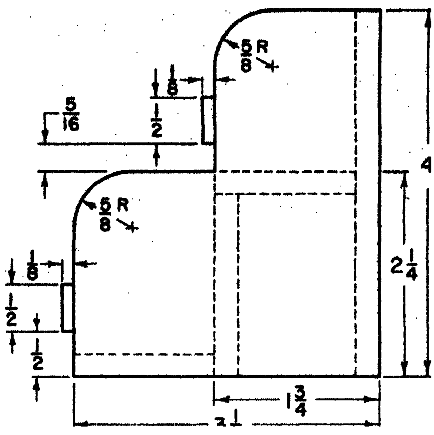
8-5. Dimensions placed on a drawing where they are easiest to read. Notice how the dimensions are "staggered" and that the extension lines *do not cross* the dimension lines. For example, the 1⅞ dimension is placed below smaller dimensions and is connected with added extension lines, so none of the lines cross. Your instructor can help make this clear. See Fig. 8-1.

8-6. The correct position for extension and dimension lines.

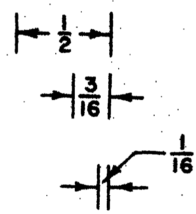
are correct and either can be used for all kinds of drawings. However, be uniform in each drawing. In the more modern method first used by aircraft companies, the dimensions

8-7. Notice that the detail (short *size*) dimensions are placed inside the overall (long *size*) dimension. *This dimension is usually omitted on machine drawings where great accuracy is required. It can be added and marked REF. (Reference). This dimension is included on house plans and other construction drawings or on any drawing where great accuracy is not required.





8-8. In this view some dimensions are shown from invisible lines. This should be done only if it helps to make the drawing of the visible surface easier to read.



8-9. Methods of dimensioning small spaces.

are placed so they are read only from the botton. Fig. 8-3. The traditional or regular method is to place dimensions so they are read from the *bottom and right side*. Fig. 8-3.

6. Letter the dimensions correctly. Most dimensions on beginning drawings are shown in *inches and fractions* of an inch. On many drawings used in industry, the dimensions are given in *decimals*. For example, instead of 1¼″, the dimension is shown as 1.250″.

WHERE AND HOW TO DIMENSION

1. Place all dimensions *outside* the views rather than right on the drawing. If possible, keep them all *between* the views. If easier to read, however, certain dimensions can be placed inside the views. Fig. 8-4. (A "view" is the part of a thing shown by the drawing—front, top, or side, for instance.)

2. Place the dimensions on the view which shows the shape the clearest. Do not put them on other views where they are not needed. Fig. 8-5. Usually the height and length are placed on the *front view*.

3. The *extension lines* should be light, sharp lines starting about 1/16″ away from the outline or object. Fig. 8-1. They should extend only slightly beyond the arrowheads of the outside dimension lines. Fig. 8-6.

4. The dimension lines should start about ⅜″ to ½″ from the outline or object. If there are several parallel dimension lines they should be ¼″ to ⅜″ apart. Fig. 8-6

5. If there are several parallel dimension lines, don't place the dimension *figures* above each other; "staggering" them makes them easier to read. Fig. 8-5.

6. Always place the detail and cation dimensions inside the overall dimensions. Fig. 8-7.

7. Always show each over-all (long size) dimension only once on the drawing. Don't repeat dimensions.

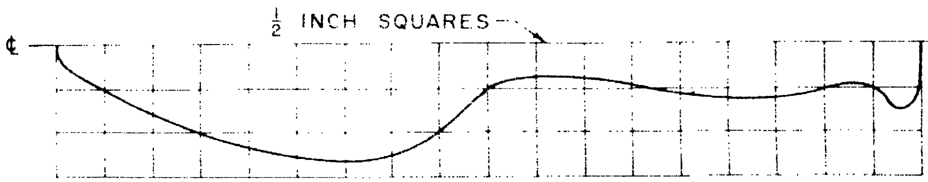
8. Never allow dimension lines to cross extension lines.

9. Never use a center line as a

dimension line. (Center lines may cross all other lines because they are lighter and are "broken" lines.)

10. Use *inches* to and including 72, and *feet and inches* above this amount. Use the mark ″ for inches and ′ for feet. But, if all dimensions are in inches, *the inch mark can be omitted.*

11. Avoid bringing an extension line from an invisible or hidden line



8-10. Only half a view is needed for a symmetrical object (the same on both sides).

(which shows a part of an object behind the surface). In some cases, especially on the side view, it may be necessary. Fig. 8-8.

12. If the space for dimensioning is small, place the arrowheads *outside* the extension lines, pointing in, as shown in Fig. 8-9.

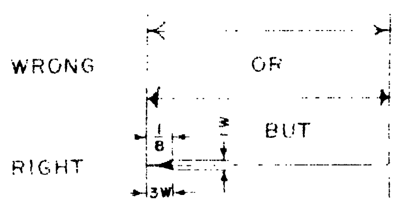
13. If the drawing is symmetrical (equal on both sides) only *half* the view is needed. The symbol ℄ on the center line is then used. Fig. 8-10.

DRAWING ARROWHEADS

Arrowheads are drawn on one or both ends of most dimension lines. Only one arrowhead is used on the dimension line for the *radius*. The appearance of your drawing is affected by the shape and quality of the arrowheads. The arrowhead should be about one unit wide and three units long (three times as long as it is wide). For the average drawing it should be about ⅛″ long. Notice the correct and incorrect arrowheads in Fig. 8-11. The correct method of making arrowheads is shown in Fig. 8-12.

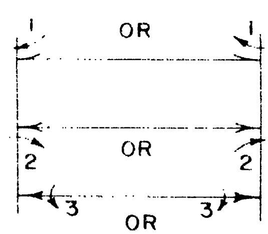
DIMENSIONING CIRCLES, ARCS, AND ANGLES

1. Always dimension the *diameter*



8-11. Correct and incorrect arrowheads.

8-12. Correct method of forming an arrowhead. For simplified shop drawings, see Section IV, Unit 33.

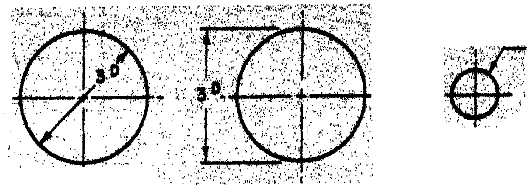


of circles, cylinders, and holes. Fig. 8-13. There are three common ways:

a. The dimension may be placed *inside the circle*. Avoid placing the dimension too close to the center lines.

b. The dimension can be placed *outside the circle*, with the dimension line either vertical or horizontal.

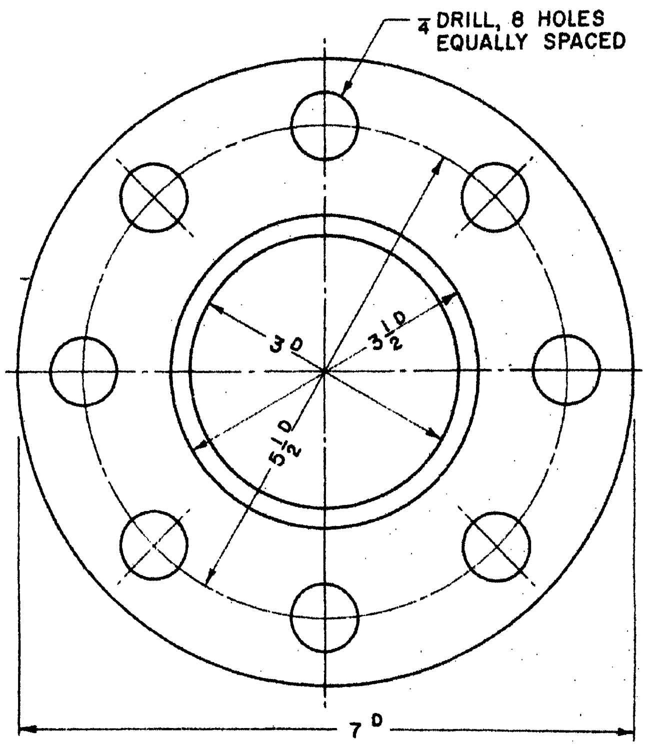
c. *Leaders* can be used. These are fine lines drawn at a 45- or 60-degree angle to the center, just touching the circumference. An arrowhead is drawn on one end and a short horizontal line on the other. Leaders can also be used to add notes to a drawing.

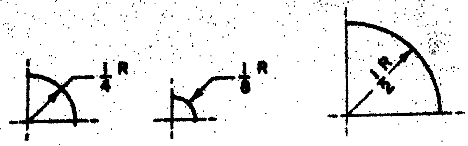


8-13. Circles should be dimensioned in one of these ways.

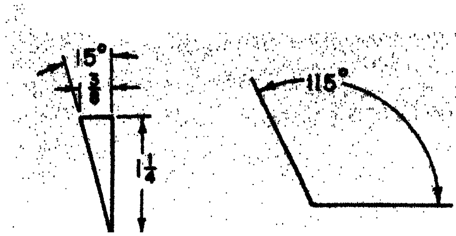
2. Place a D after the dimension, if it is not perfectly clear that it is

8-14. The correct method of dimensioning an object in which there are several equally spaced holes.





8-15. Dimensioning an arc. Use any one of the methods shown.



8-16. Dimensioning an angle.

a circle or hole. D means "diameter."

3. Where there are several equal size holes around a circle, indicate the size of the hole and the number. Fig. 8-14. If they are not equally spaced apart, show the location of the holes by lettering in the *angle* between the holes.

4. Give the *radius* of an arc. Place an R after the dimension. Follow one of the methods shown in Fig. 8-15, according to how big the space you have for the dimension.

5. Place dimensions for angles so they can be read without turning the paper. Fig. 8-16.

ADDING NOTES TO DRAWINGS

Notes are placed on the drawing to give the workman additional information not shown by the dimensions.

Here is some typical information that might be added to a drawing:

1. In a one-view drawing, the thickness and kind of material to be used. Fig. 6-6.

2. Information about the kind of material to use.

3. A special process that must be completed such as hardening, annealing, tempering, or twisting.

4. A special dimension that may vary depending on the use of the drawing. For example, a clock frame may have the note "drill to fit clock," thus showing the diameter of the opening.

5. A dimension not shown on a two-view drawing. For example, on a two-view drawing of a book case there might be the note "back—¼" plywood."

6. A special kind of finish to be applied.

7. Several holes of the same size could be indicated with a note, "all holes ¼"."

8. On a casting the note might be added, "all fillets and rounds ⅛R."

9. Any other information not given in the dimensions or in the title block or strip that would be useful to the person using the drawing.

The notes are placed on the drawing in a convenient and easy-to-read location. On the average drawing they are lettered in ⅛" capitals.

Section I

9. Drawing To Scale

Would you see this railroad train at your local station? Fig. 9-1. It looks real enough to be a full-size train. Actually, however, it is a model made to a scale of 3/16" to the foot (3/16" = 1'-0"). Many objects are too large to draw full-size. For example, you couldn't make a full-size drawing of the state you live in or your school's football field. A drawing does not have to be full size to make it completely useful. The *lines* show the *shape* of the object and the *dimensions* tell the *size*. Drawings that are made larger or smaller than full size are called *scale drawings*. Notice various balls used in sports. Fig. 9-2. The marble, Fig. 9-3, is drawn *double size*, the golf ball to *full size*, and the others to smaller scales. Scale drawings can be made with an ordinary rule. If you are using an architect's scale, however, be sure to study Unit 24 in Section III.

MAKING A SCALE DRAWING

To make a scale drawing with an ordinary rule proceed as follows:

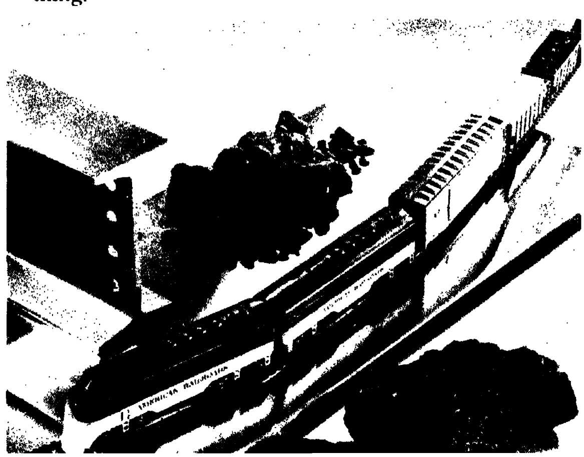
1. Determine the scale to use. Suppose you wish to make a drawing of this metal wastepaper basket: Fig. 9-4. It is 10" in diameter and 12" high. It would be impossible to make it full size on an 8½" x 11" sheet of paper. If you make it half size (6" equals 1', or 6" = 1'-0") it will fit very nicely on the paper. Fig 9-5. Always make the scale as large as possible so the drawing will look well on the paper.

2. Make the scale drawing. In this drawing every inch is drawn ½" long, every ½" is drawn ¼", etc. To lay out the height of the basket (12"), measure 6" on your rule. To lay out the diameter of the basket, measure 5". Follow this technique for all measurements.

OTHER SCALE DRAWINGS

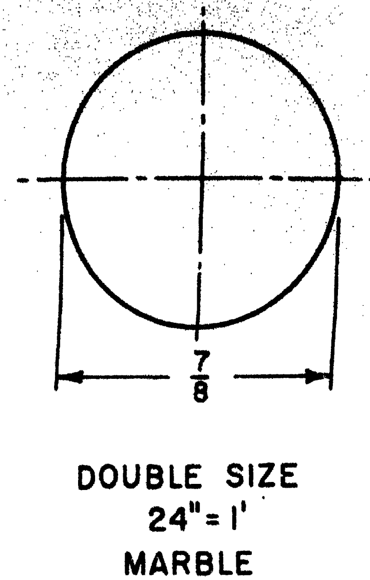
The larger the object the smaller the scale you need. Suppose you want to draw a football field. Fig. 9-6.

9-1. This scale model looks like the real thing.



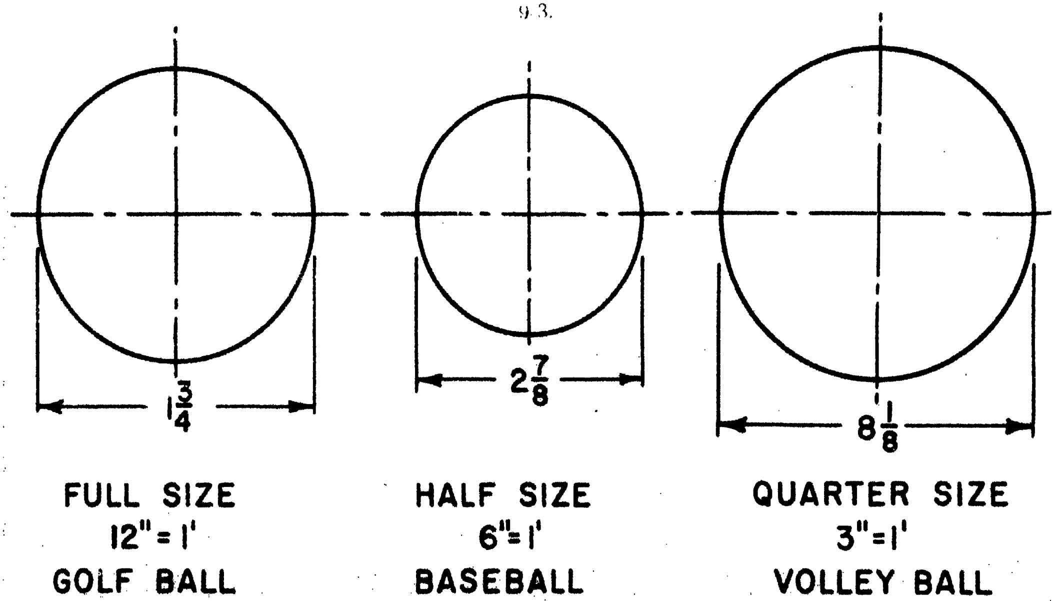
9-2. You can compare ball sizes on this photograph.

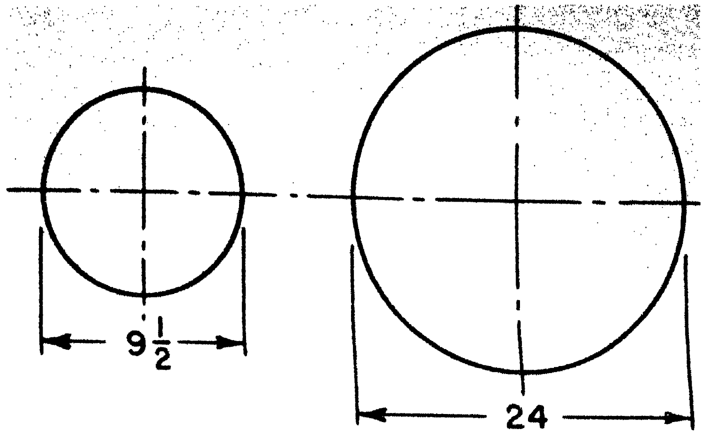
9-3.



9-3. Scale drawings of several kinds of balls. Note that by using different scales the balls appear to be of similar size. The dimensions, however, tell the real story.

9-3.



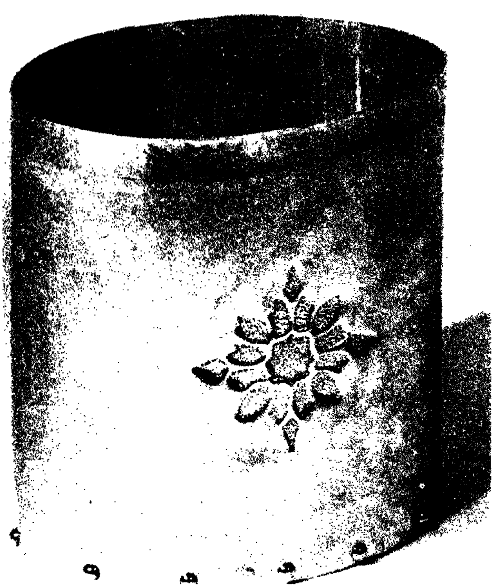


ONE-EIGHTH SIZE **ONE-TWELFTH SIZE**
1" = 1'

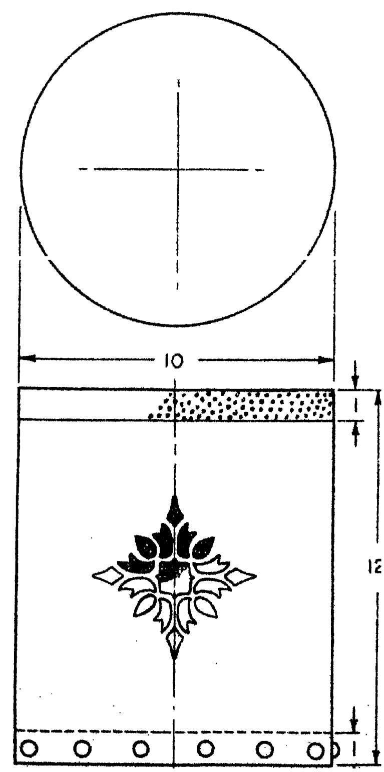
BASKETBALL **BEACH BALL**

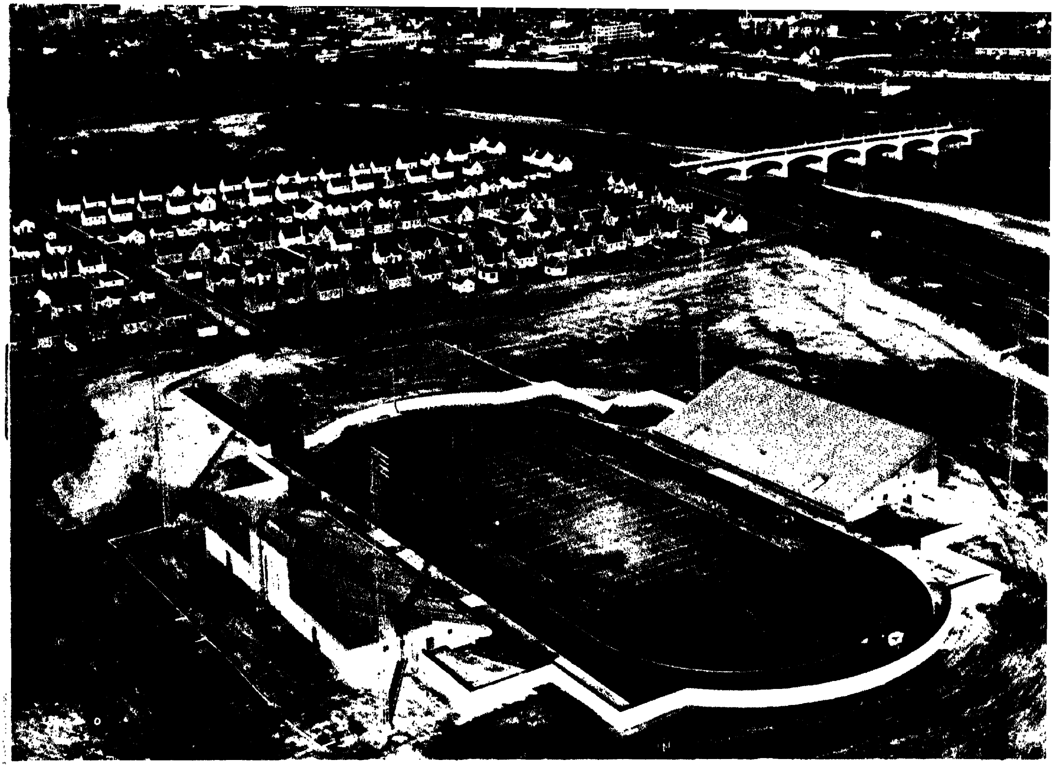
The field is 160 feet wide and 360 feet long. To get this on 8½" x 11" paper, you will need a scale of 1/16" equals 1 yard (3 feet). This will mean that the field is drawn 7½" long. The 10-yard markers will be ⅝" apart. Fig. 9-7. Your instructor will help you with scale on this kind of drawing.

9-4. Wastepaper basket.



9-5. A scale drawing of the wastepaper basket.





9-6. You can get some idea of the size of a football field by comparing it with the houses.

Suppose you wish to make a layout of your room at home. This is often done on squared paper that has four or eight squares to the inch. A convenient scale then would be ½″ equals 1 foot. If your room is 8 feet wide and 12 feet long, the actual size of the drawing will be 4″ x 6″. On a larger room you might use a scale of ¼″ = 1′.

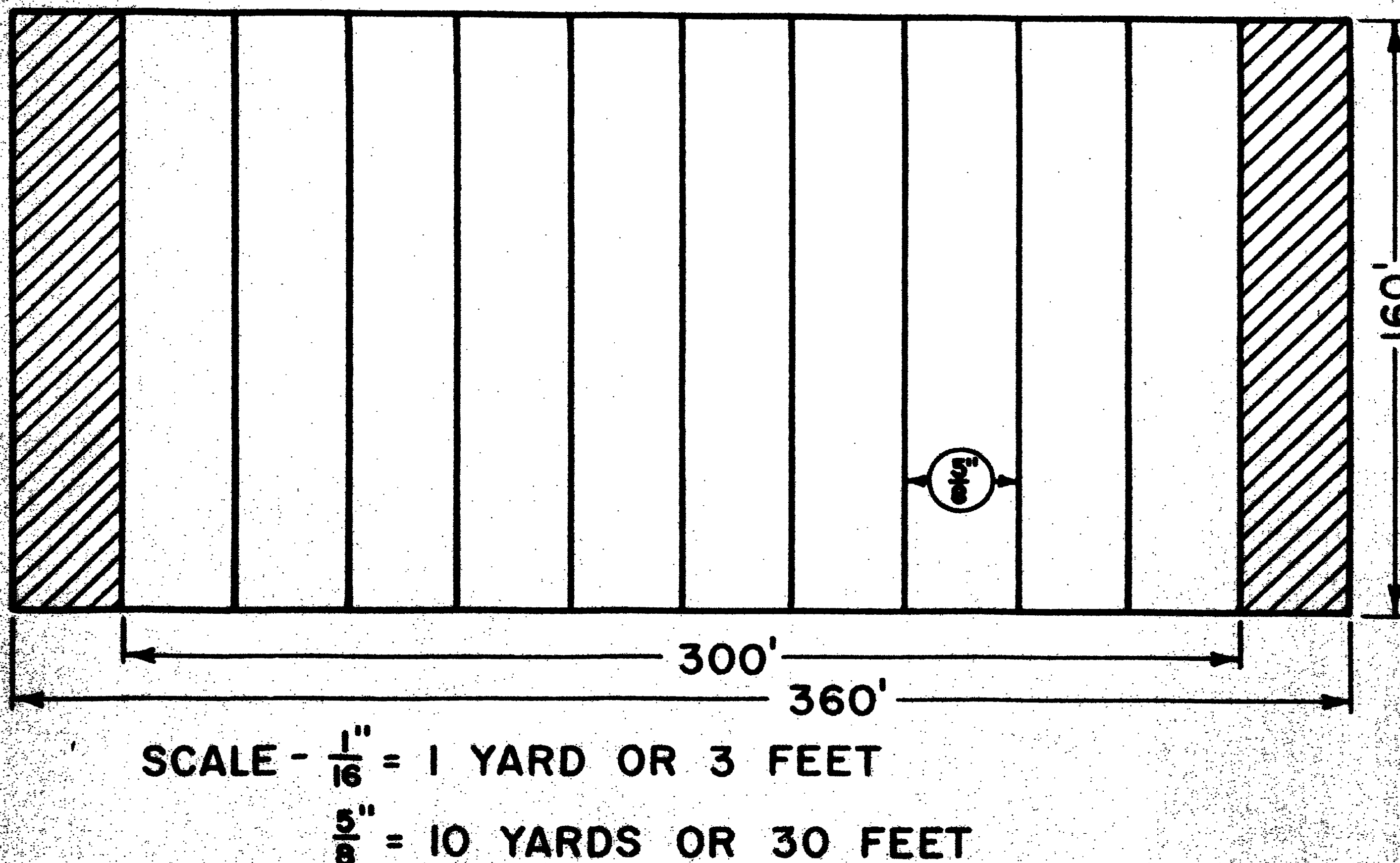
POINTS TO REMEMBER

1. When using an ordinary foot rule to measure with, follow one of these common scales:

a. 24 inches equals 1 foot – double size (24″ = 1′).
b. 12 inches equals 1 foot–full size (12″ = 1′).
c. 6 inches equals 1 foot-size (6″ = 1′).
d. 3 inches equals 1 foot–quarter size (3″ = 1′).
e. 1 inch equals 1 foot – one-twelfth size (1″ = 1′).
f. ½ inch equals 1 foot – one twenty-fourth size (½″ = 1′).
g. ¼ inch equals 1 foot – one forty-eighth size (¼″ = 1′).

2. Make sure you indicate on the record strip or title block the scale used on the drawing. For example, for the wastepaper basket, Fig. 9-5, indicate either *half size* or 6″ = 1′-0″.

3. Remember, the person who uses your drawing to make something *never* measures the drawing itself. He always follows the dimensions you have indicated on the drawing.

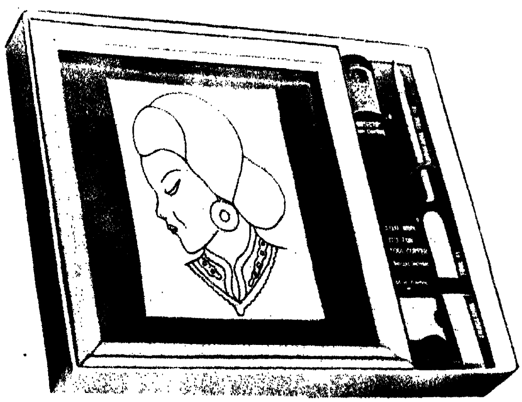


9-7. This scale drawing of a football field is all that you would need to lay out a full-sized one.

Section I

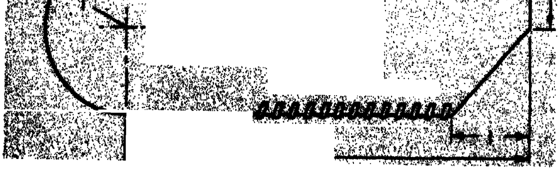
10. Making a Pattern

For many things you want to make —whether it's a kite, a sail for a boat, a billfold, a shop apron, or a dog's dish—you need a pattern. Fig. 10-1. A pattern is a full-size outline (one-view drawing) that is *drawn on* a material or *transferred* to it. The material can then be cut out, folded, bent or shaped, and assembled.



10-1. Here's a pattern for making a metal plaque from thin copper. This could not be copied as is because it is not full size.

10-2. A simple pattern drawing for a leather comb case.



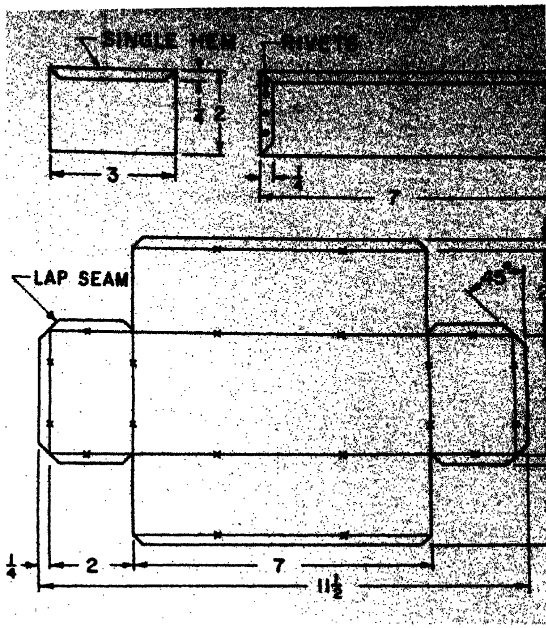
Patterns are used in making things of paper, cloth, sheet metal, plastics, leather, wood, and other thin materials. Fig. 10-2. Have you ever watched someone who sews? First she buys a pattern which is spread out and pinned to the cloth and the cloth cut out around the pattern pieces. The pattern is made so the material can be shaped to three dimensions. Imagine your own coat or pants as being flat cloth at one time. You will do the same thing with the patterns you use in shopwork.

There are three ways to get a pattern that you need: make your own, enlarge a smaller one, or use a full-size, ready-made pattern.

1. Make your own. If the object is a simple one, you can make a layout or pattern directly on the material. For example, here is a pattern for a simple sheet-metal marble box. Fig. 10-3. You will also learn how to make more difficult patterns in sheet metal such as patterns for funnels, pails, and scoops. See Unit 2 in Section IV.

2. Enlarge a smaller pattern. Most project plans contain a small

drawing of all the parts. If certain parts are irregular in shape, the drawing is usually placed on squared paper. Fig. 10-4. You can then make a full-size pattern as described in the next unit.

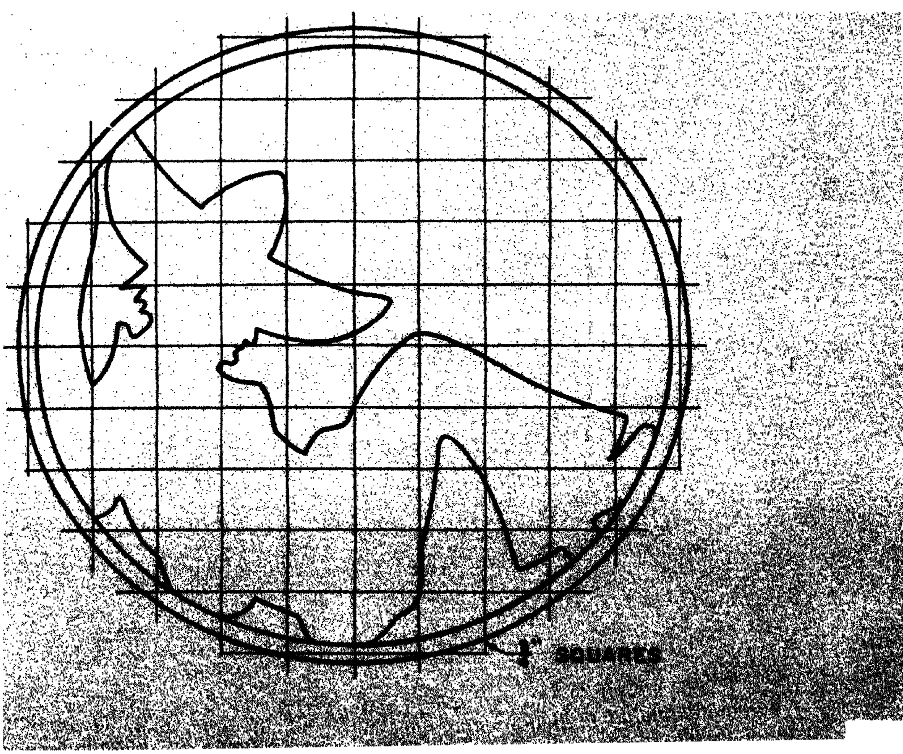


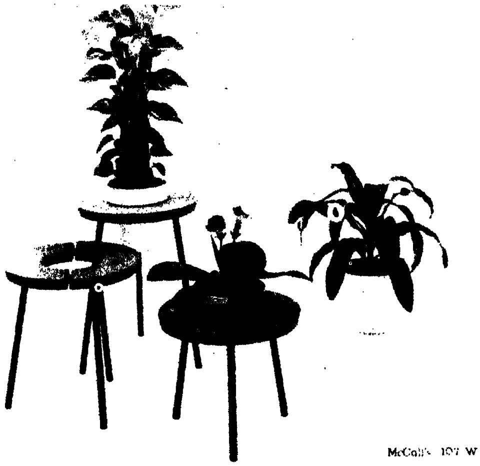
10-3. A pattern drawing of a sheet-metal box.

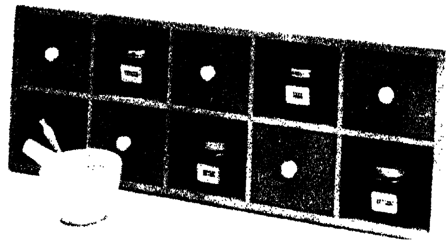
3. Get a full-size pattern.

Some projects in books or magazines are accompanied by patterns that are full size. Fig. 10-5. You can also purchase full-size patterns for things made of metal or wood. These full-size patterns can be placed directly on the material. Then the pattern is traced on or transferred to the ma-

10-4. A pattern on squared paper. You could enlarge this to any size you want by following the directions in the next unit.

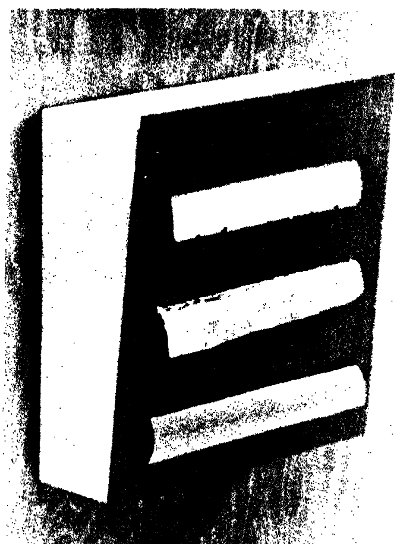




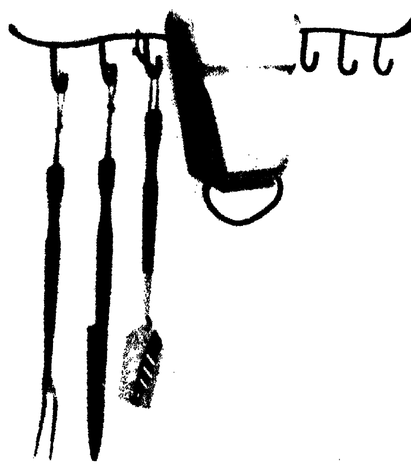


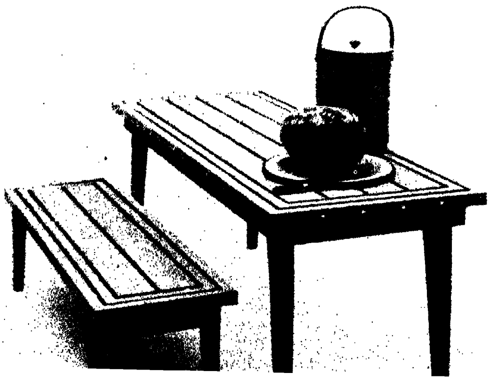
McCall's 107 W

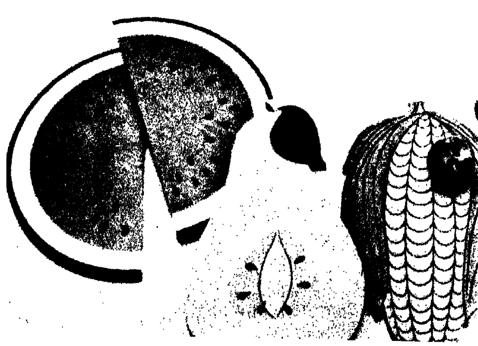
10-5. Full-size patterns are available for projects like these. See the Appendix—Project Source No. 14.

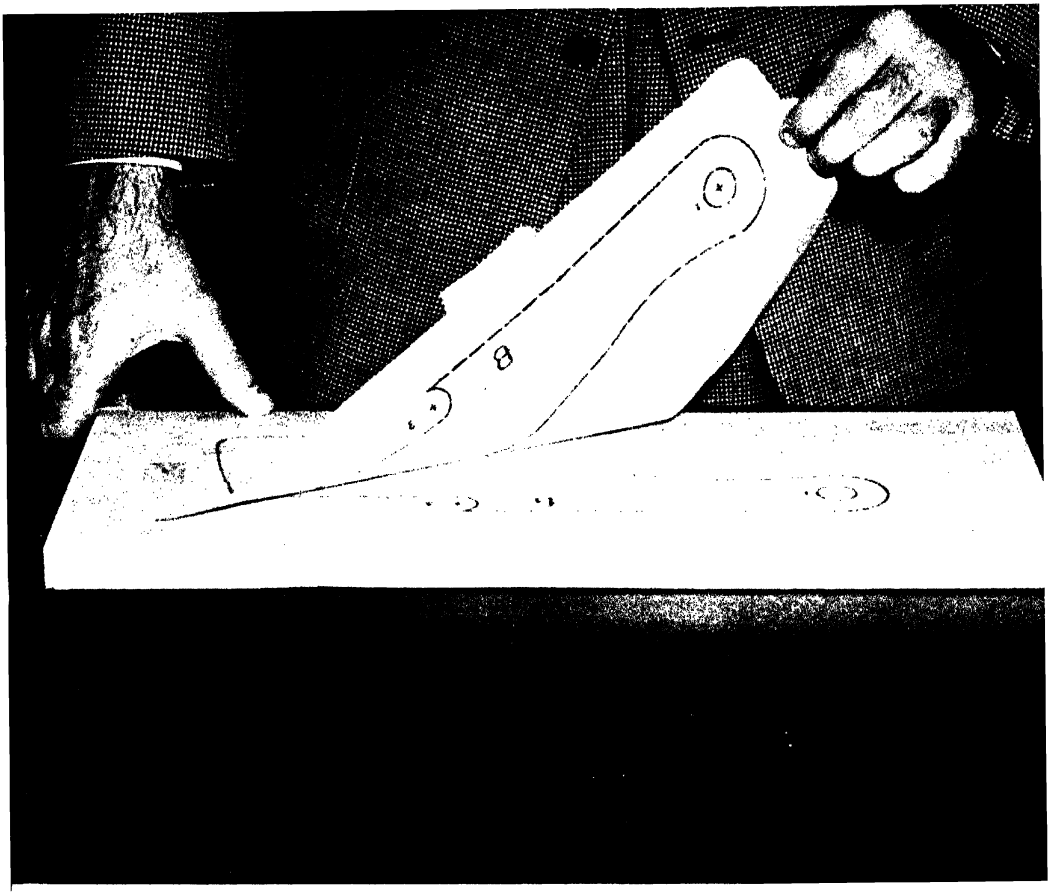


McCall's 110 W









10-6. Using a full-size pattern to make a part for a woodworking project.

terial. Fig. 10-6. These patterns are used much like the patterns in sewing. Sometimes, when many objects of the same shape are to be built, a pattern or template of sheet metal or plywood is made. This pattern can be used over and over again to trace the shape on the material.

Section I

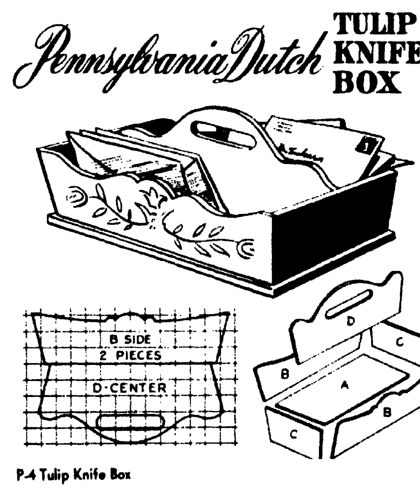
11. Enlarging a Pattern or Making It Smaller

Many times in a book or magazine you will find the pattern of a project that you would like to build. The only problem is that it's less than full size. Your first job is to enlarge it so that you can trace or transfer it to the material. This is a procedure you will do often in making woodworking, metalworking, or even plastic or leather projects. The steps are simple but you need to follow them carefully to make the full-size pattern exactly like the small one.

Suppose you have seen this design in a book: Fig. 11-1. In most books and magazines the design is covered with squares. A note tells you what

11-1. A knife box project.

1 pc. 6¾″ by 12″	bottom	(A)
2 pcs. 3⅛″ by 13¼″	sides	(B)
2 pcs. 3⅛″ by 7⅛″	ends	(C)
1 pc. 5″ by 12⅜″	center	(D)

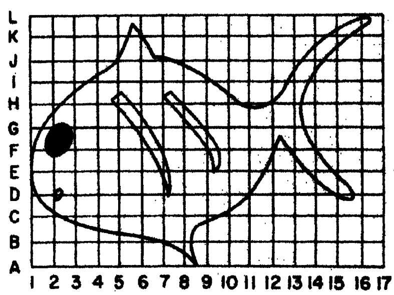


11-2. Here is a drawing on squared paper for the center and the two side pieces of the knife box on 1″ squares. You could make a full-size pattern for these. A full-size pattern of the other parts can be made directly on the material. They are: A. Bottom, 6¾″ x 12″. C. Ends, 3⅛″ x 7⅛″.

size the full-size squares must be. Fig. 11-2. Sometimes, however, you find a design or photo that has no squares. If this design is about one fourth the size you would like to have it, first cover the design with ¼″ squares. If the design is in a book, draw the squares on transparent paper and clip the paper over the page. Fig. 11-3. Now proceed as follows:

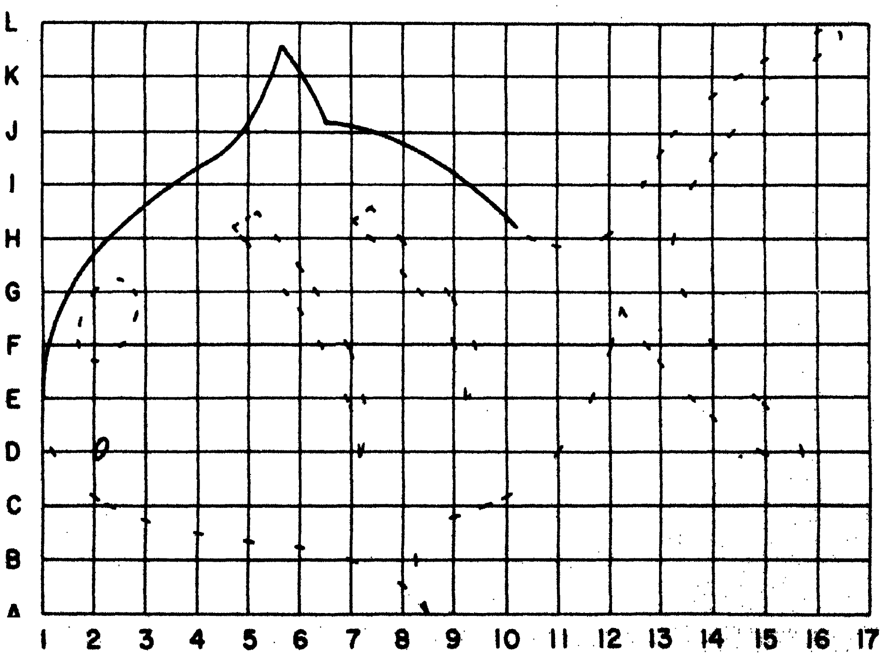
1. Secure a large piece of paper and draw squares of the full size. For example, if the drawing says, "one-inch squares," make your squares this size. Start in the lower left-hand corner of both the original drawing and the full-size sheet. Letter up the left side, A, B, C, etc. Number across the bottom, 1, 2, 3, etc. Fig. 11-4.

11-3. Could you make a full-size pattern of this coat rack if you knew that it i 26" long?



11-4. The correct method of enlarging a pattern. Notice that the numbers across the bottom and the letters up the side are the same in both the original drawing and the enlarged one.

11-5. The full size pattern.



2. Locate points on the drawing. Transfer them to the full-size pattern. Continue to locate enough points to make the outline take shape.

3. After enough points are located, use a French, or irregular, curve to trace the outline. Fig. 11-5. Locate three points at a time on a section of the curve. Draw a line not quite up to the outside points. Move the French curve and repeat this procedure. Read Unit 5, Section I on "Drawing Irregular Curves."

4. If you are in the shop you can bend a piece of wire solder to follow the various points. Trace the line.

5. If the object is equal on both sides, you need to trace only half the pattern. Then fold the paper down the center and cut out the full pattern or trace the full pattern by placing carbon paper between the folds, carbon side down on the blank half.

6. A pattern can be made smaller by reversing this procedure.

7. You can use this full-size pattern in one of several ways:

a. Cut out the pattern with scissors and trace around it on the material.

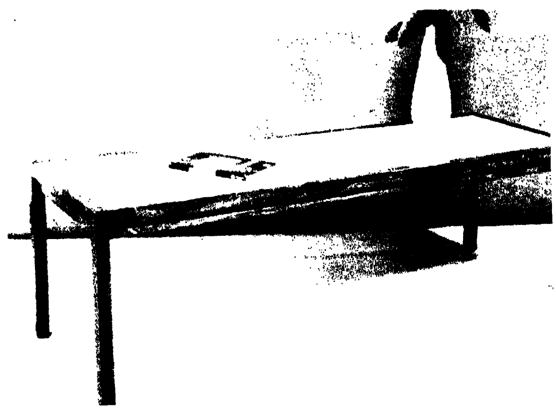
b. Cut out the pattern with scissors and paste or glue it on the material.

c. Place carbon paper between the pattern and the material and trace the design.

Section I

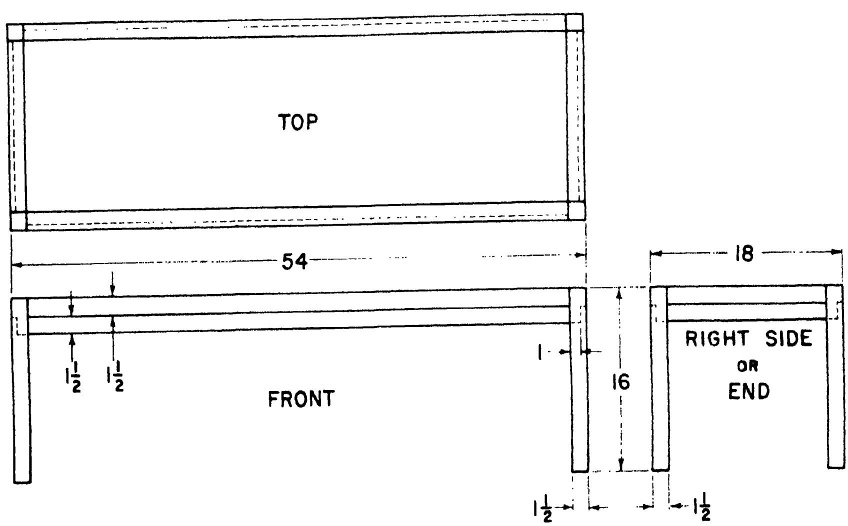
12. Making a Working Drawing

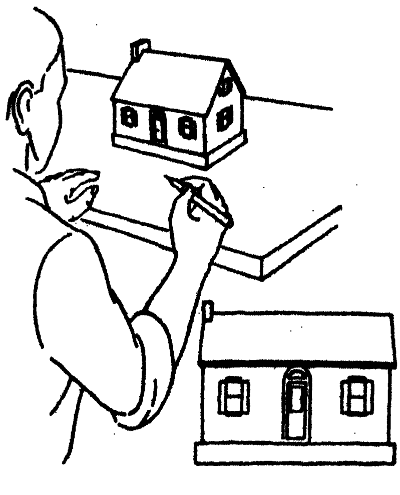
Working drawings are made for building or constructing an object. Fig. 12-1. The drawing must show the exact shape and size. This can best be done by making a drawing of two, three, or more views. This is called a *working drawing* because it is used to "work from" when making

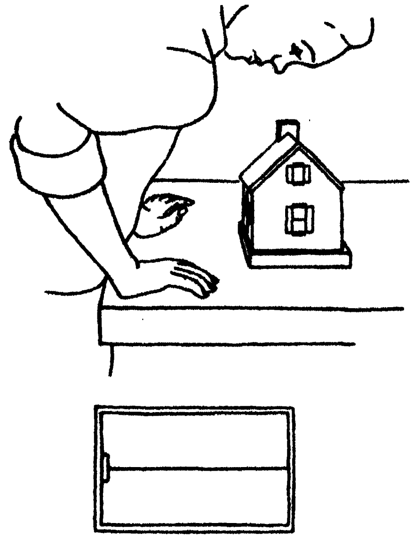


12-1. This coffee table might be built from the working drawing shown in Fig. 12-2.

12-2. A three-view working drawing of the coffee table.

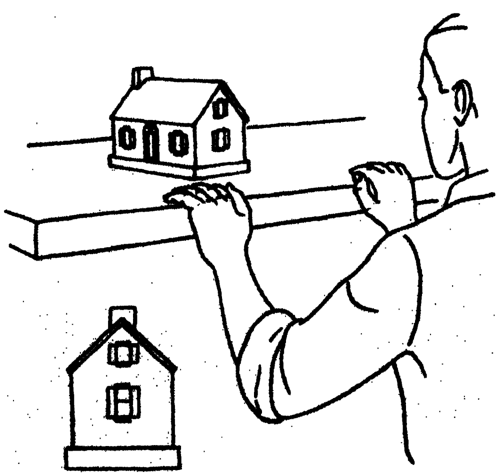


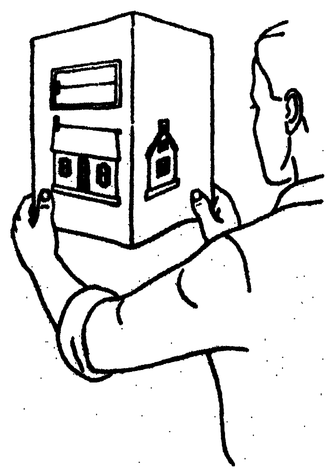




12-3. Look at the front of the coin bank, as this fellow is doing. This front view shows the height and length, as well as details of the front surface.

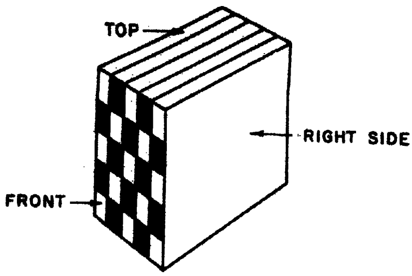
12-4. The top view shows the width and length, and details of the ridge, chimney, and gutters.



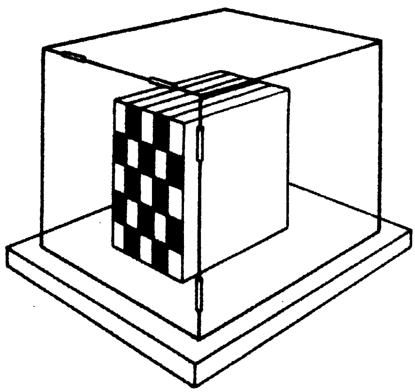


12-5. The right side, sometimes called the end view, shows the height and width, and side details—windows, etc.

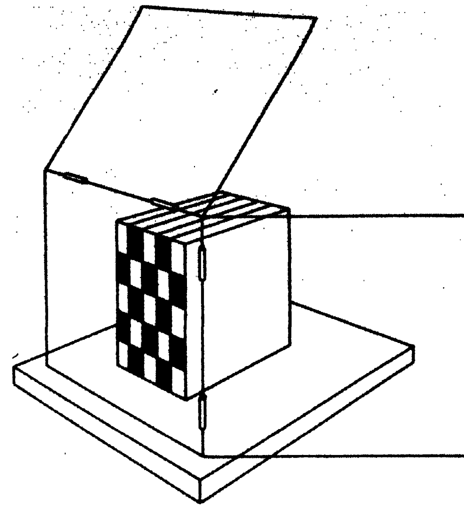
12-6. This is the way the three views of the bank are placed on a paper, folded to show how the views are drawn.



12-7. A pictorial drawing of a design block. Each of the three surfaces can be easily identified. Study these surfaces.



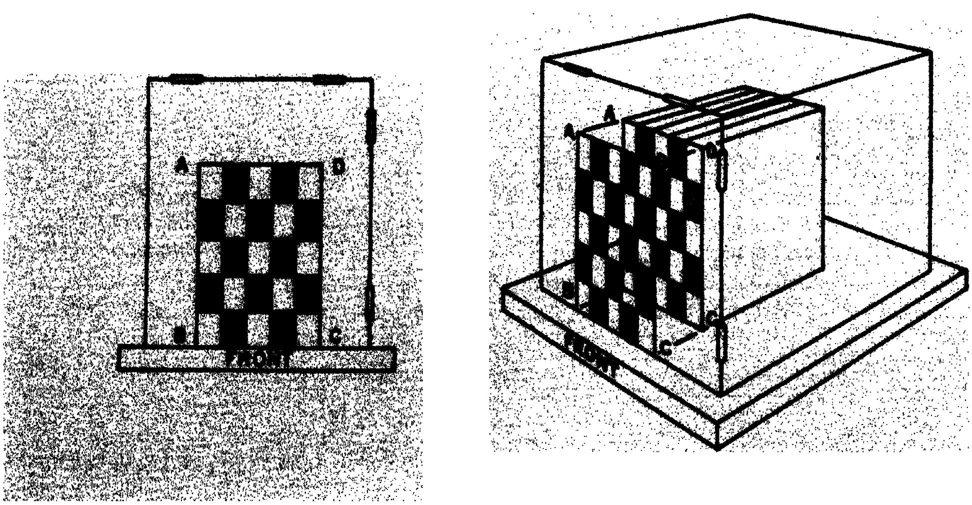
12-8. The design block inside a clear plastic box. Notice the way the top and side of the box are hinged to the front.

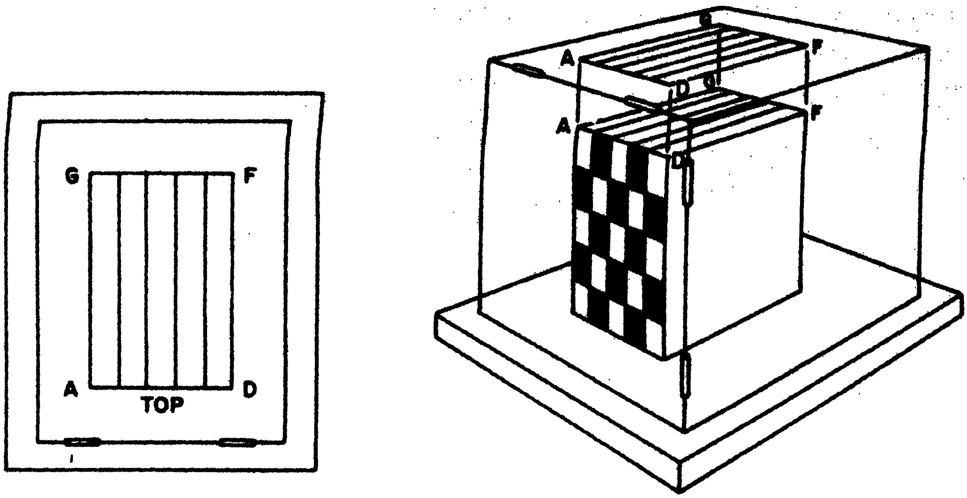


12-9. The way in which the plastic box can be opened up.

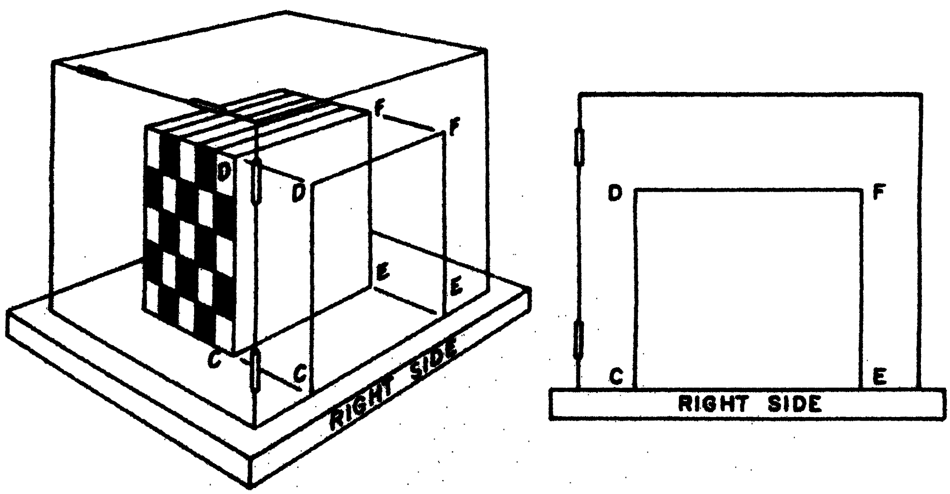
anything. Fig. 12-2. It is also called a *multi-view drawing* because it shows the several views. Still another name is *orthographic projection,* which describes the idea behind making the drawing.

12-10. Drawing the front view of the block on the front of the plastic box. The corners are marked A, B, C, and D.

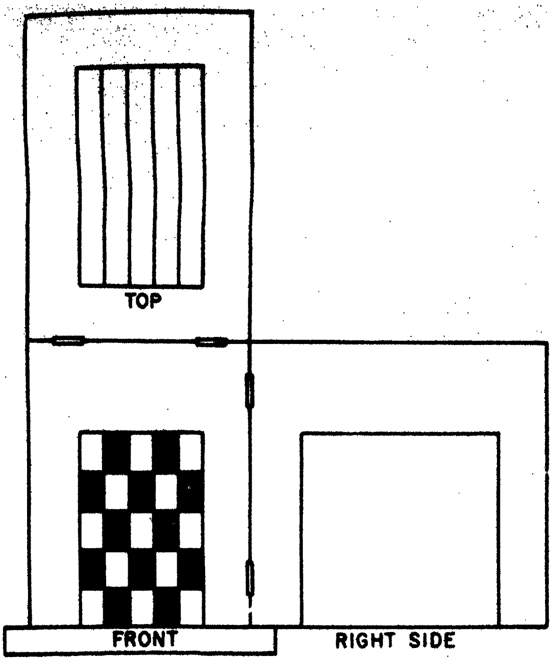




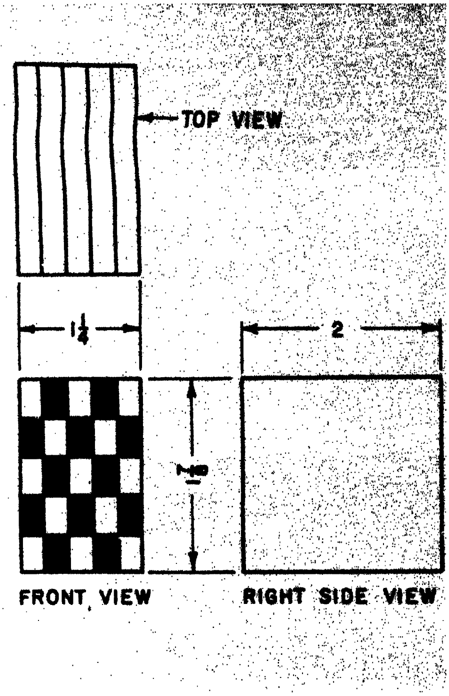
12-11. Drawing the top view on the top of the box. The edge AD is the same as the edge AD on the front view.



12-12. Drawing the right-side view on the right side of the box. Notice the edge DC is the same as the edge DC on the front view.



12-13. Now the box is opened up and you can see the three views in their proper positions.



12-14. The plastic box is removed and you see the three-view drawing of the block.

UNDERSTANDING WORKING DRAWINGS

There are two easy ways to understand how a working drawing is made. One method is the *natural way* of looking at the different views. Suppose you want to make a drawing of a coin bank. First look at the front of it. What do you see? You see the outline of the front view showing the *height* and *length*. Fig. 12-3. When you look down on the house you see the top view, which shows the *width* and *length*. Fig. 12-4. When you look at the right side you see the right side view. You see the *height* and *width*. Fig. 12-5. Each view shows the true size, shape, and other details of that part of the house. The three views when placed on a single piece of paper show how the object looks as a *working drawing*. Fig. 12-6.

A second way to understand working drawings is to imagine the object in a *clear plastic box*. Figs. 12-7 and 12-8. Notice how the box is hinged at the top and the right side of the front surface. Fig. 12-9. Sketch the front view on the front surface of the box. Fig. 12-10. Sketch the top view on the top surface. Fig. 12-11. Finally, sketch the right side view on the right side of the box. Fig. 12-12. When you open out the sides of the box you will see the three views in their proper positions. Fig. 12-13. If you now remove the lines of the box itself, the working drawing will look like Fig. 12-14.

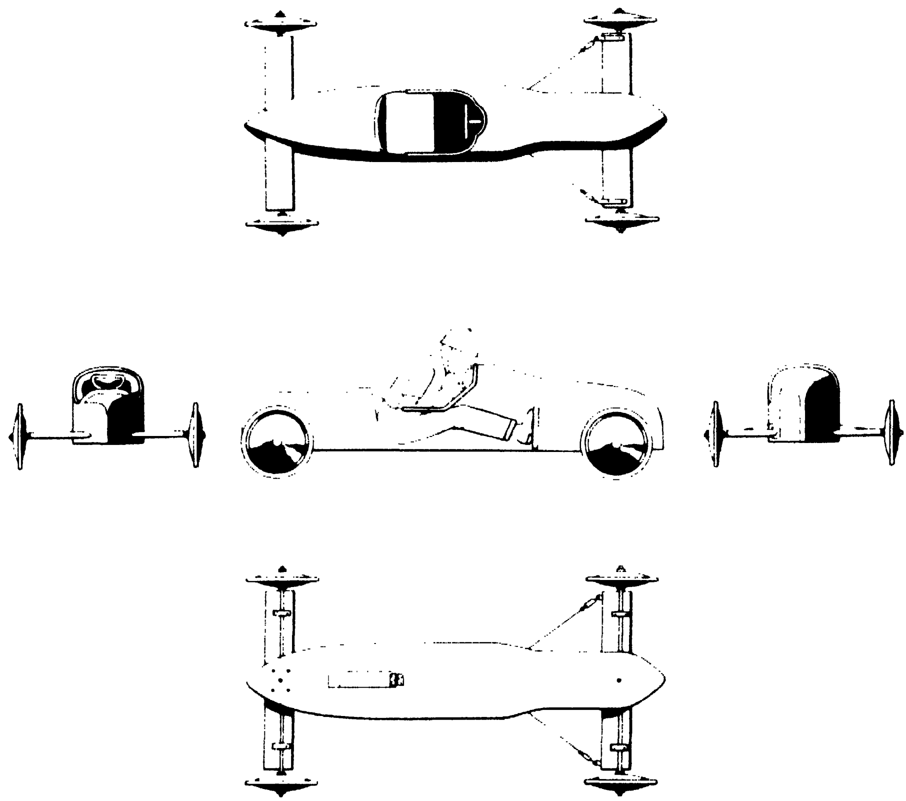
12-15. To show this soap box derby racer, five views are needed. A bottom view and a left-side view are added.

Most objects are said to have *six sides*—namely, a front, top, right side, left side, bottom, and back. For most drawing only the front, top, and right side are shown. In some cases, such as in this drawing of a soapbox derby racer, additional views are needed: Figs. 12-15 and 12-16.

In making a working drawing the views can be completed in part by *projection*, "making" one view by using the width, height or length of a complete view. In Fig. 12-17, the height of the front view can be "projected" to form the height of the side view. It is possible also to complete the side view by projection. First draw the front and top views. Then draw a light line at an angle of 45 degrees at the upper right-hand corner. Now project the *height* from the front view and the *width* from the top view as shown. Notice also how the width can be projected with a compass by drawing light arcs from the top view to the side view.

THINGS TO REMEMBER ABOUT WORKING DRAWINGS

1. The front view (one of the principal views) should always be the



12-16. The five views of the soap box derby racer.

best one or the one that shows the most distinct shape of the object.

2. Arrange the front view so that the other views will have the fewest number of hidden lines. See the next unit.

3. Show only the number of views that you actually need. Sometimes you will need two, most often three and, in rare cases, four or more.

4. The *front view* is placed in the lower left-hand corner of the drawing paper.

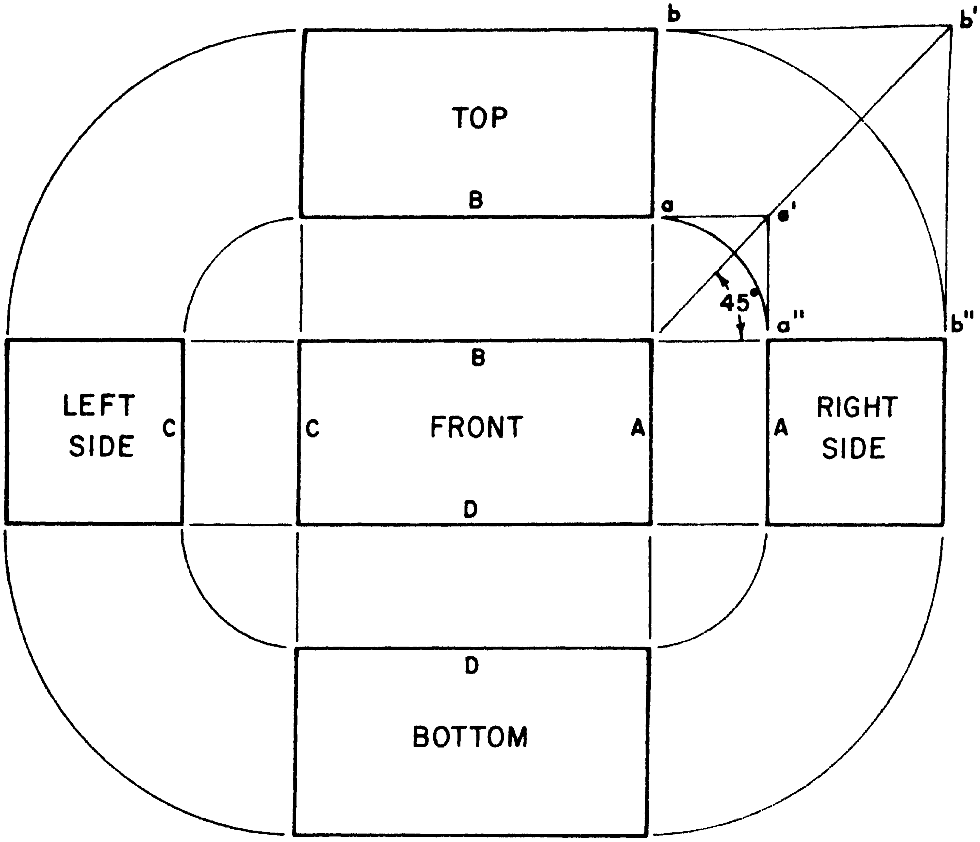
5. The *top view* is always placed in line with and directly above the *front view*.

6. The *right-side view* (sometimes called the *end view*) is in line with and directly to the right of the front view.

7. The height (sometimes called thickness) and the length of the object are shown in the *front view*.

8. The width (sometimes called the depth) and length of the object are shown in the *top view*.

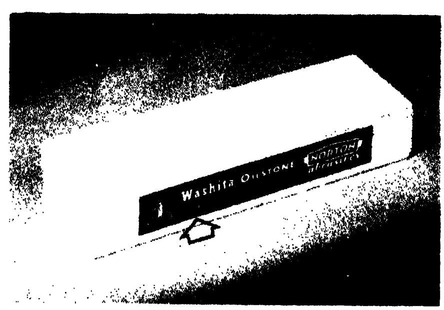
9. The height (or thickness) and width (or depth) of the object are shown in the *right-side view*.



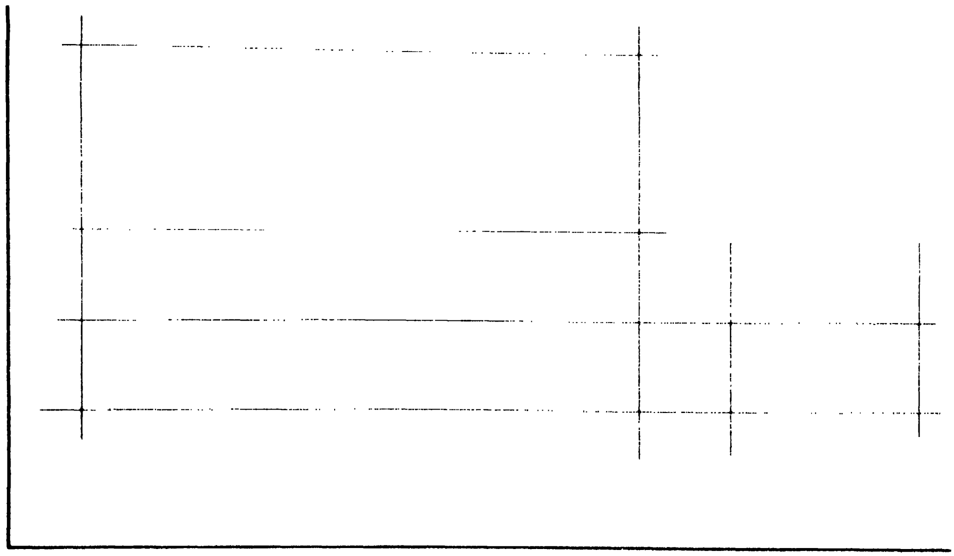
12-17. Notice the location of the five views and how the views can be projected one to the other. The height of the front view can be projected to the height of the right- or left-side view. The length can be projected from the front view to the top or bottom view. The width can be projected from the top view to the right- or left-side view by drawing arcs a-a″, b-b″. The width can be projected from the top to the right side by drawing a line at 45 degrees and then projecting a line from a to a′ to a″ and b to b′ to b″.

10. Center the whole drawing on the page.

11. Allow about ½″ to 1″ between views.

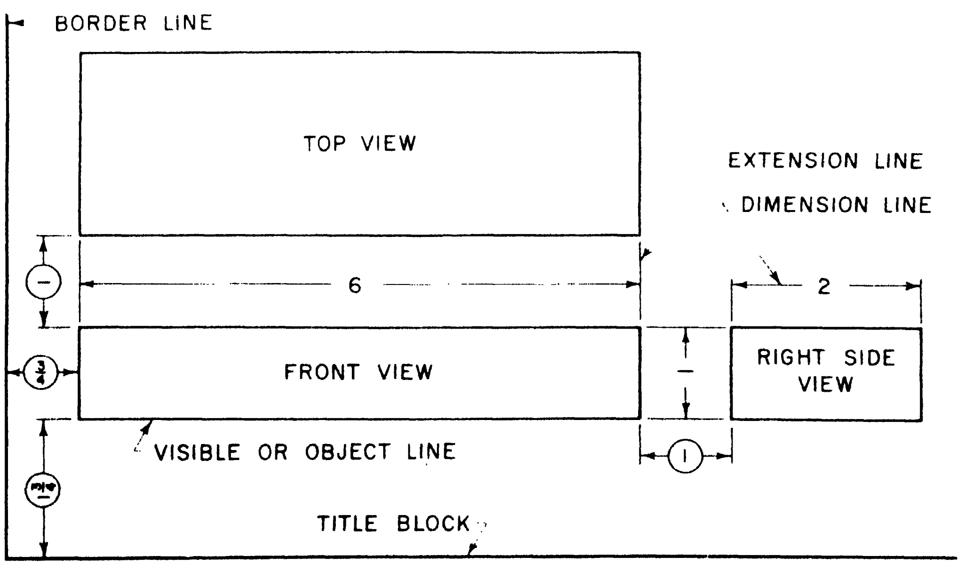


12-18. An oilstone is a simple rectangular shape. The arrow shows the side selected for the front view.



12-19. Blocking in the three views with light construction lines. These lines should be made as light as possible. Don't worry about the corners being crossed. These can be erased after the drawing is completed.

12-20. The three-view drawing of the oilstone. The dimensions that are circled are there for your convenience. If you make the drawing, do not include these.



MAKING A THREE-VIEW DRAWING

Let's try to make a simple three-view drawing of something you use constantly in the school shop—an oilstone. Fig. 12-18.

1. Draw the border line and title block or record strip as you did for a one-view drawing. See Unit 6.

2. Lay out the drawing inside the border so that it is well balanced. Remember that you have an area of $7\frac{3}{8}''$ x $10\frac{1}{2}''$ inside the *border lines* and *title block*. First determine the length (6″) and width (2″) of the object. Allow space between the views (1″). The total distance, then, horizontally, is 9″ (6″ + 2″ + 1″). This means that you should start $\frac{3}{4}''$ in from the left border line. The thickness of the oilstone is 1″ and the width 2″, with a space between views of 1″. This makes a total of 4″. This means there is $3\frac{3}{8}''$ remaining. This divided in half is $1\frac{11}{16}''$ ($1\frac{3}{4}''$ would be close enough). The distance you should start up from the title block is therefore $1\frac{3}{4}''$.

3. With your rule held against the triangle, make a short dash that will locate the horizontal lines of the views of the object.

4. With your rule held against the upper edge of the T square, make a short dash that will locate the vertical lines of the object.

5. Draw light horizontal and vertical lines to "block in" the object as shown in Fig. 12-19.

6. Retrace the outline of each view of the object with an H or 2H pencil. Erase the construction lines.

7. Draw in the dimension lines and extension lines.

8. Add the dimensions and notes.

9. Darken in the border line and letter the information in the title block or record strip. Fig. 12-20.

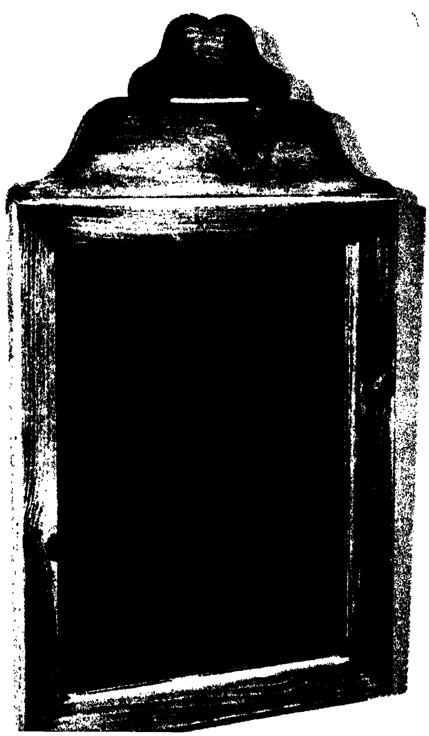
Section I

13. Drawing Views With Hidden Surfaces

If you removed the lead from the the pencil you are using there would be a hole through it. Fig. 13-1. From the side of the pencil you couldn't see this hole but you'd know it was there. In a working drawing this hole would be shown with *invisible* or *hidden* lines. These lines are used on all view drawings to show edges, holes, corners, and surfaces that cannot be seen from that view but are a part of the object.

13-1. An ordinary lead pencil with the lead removed.

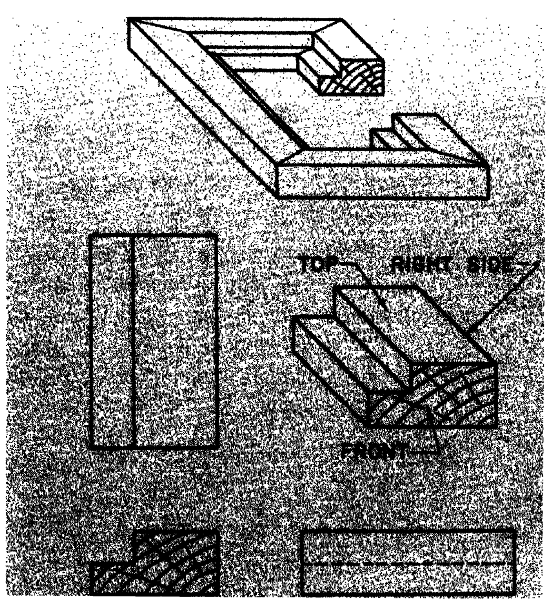
13-2. A mirror frame like this would have a rabbet edge around the back where the mirror fits.

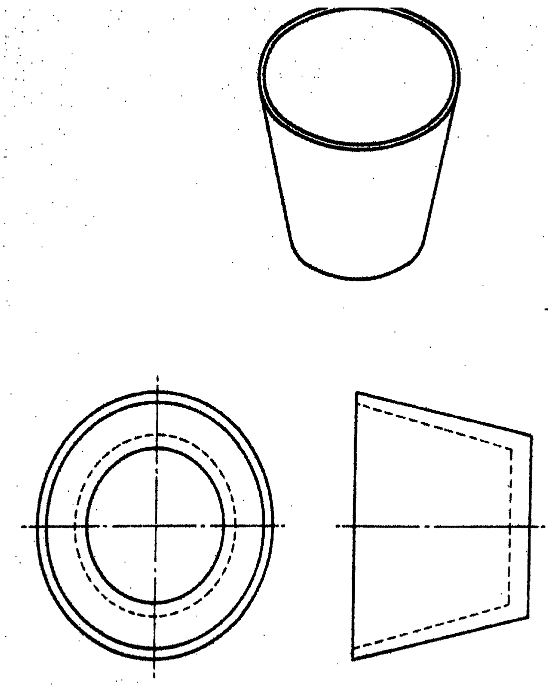


USING INVISIBLE OR HIDDEN LINES

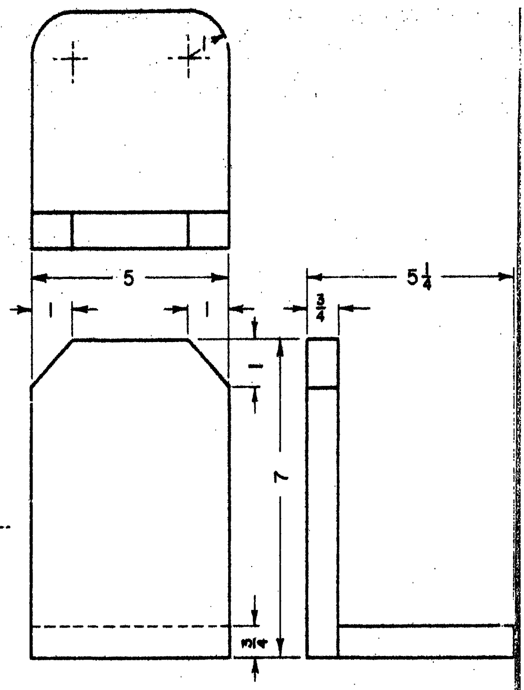
Fig. 13-2 shows a section of a mirror frame with a rabbet edge into which the glass and picture fit. Fig. 13-3. Notice that from the front and top views there would be no invisible or hidden lines. On the side view, how-

13-3. To draw a three-view section of the frame, an invisible line is needed on the right-side view.





13-4. Here is a pictorial and a two-view drawing of a turned bowl. Notice that in the corners on the side view the dashes forming the invisible line join.



13-5. The three-view drawing of a book-end. The invisible line shows the thickness of the base on the front view.

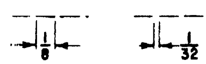
ever, a hidden line is needed to show the inside corner of the rabbet.

The turned wooden bowl is illustrated with a pictorial sketch and a two-view working drawing. Fig. 13-4. Invisible lines are needed in both views. Can you tell what part of the bowl each of these lines represents? A working drawing of a bookend is shown in Fig. 13-5. One hidden line is required on the front view. Why?

RULES TO FOLLOW FOR HIDDEN, OR INVISIBLE, LINES

1. Make the dashes of equal length (about ⅛") with an equal amount of white space ($\frac{1}{32}$") between. Fig. 13-6.

2. If two invisible lines are parallel to one another, see that the dashes are "staggered." Fig. 13-1.



13-6. The correct method of drawing an invisible line. This line should be about the same weight, but slightly lighter than the visible, or object, line.

3. Invisible lines should always start and stop with one of the object or outline lines. Never start with a white space except when it is a continuation of a solid line.

4. When invisible lines join in a corner or cross each other, always cross or join the dashes, not the white space. Fig. 13-4.

5. The weight of the line should be somewhat lighter than the outline or object lines.

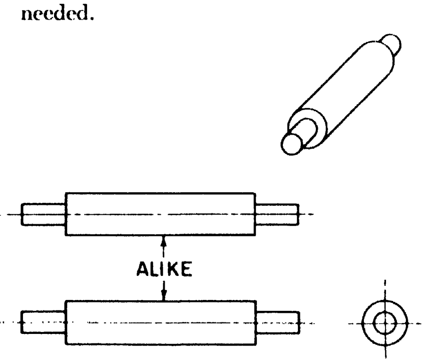
14. Making a Working Drawing With Two Views

What would a working drawing of a rolling pin look like? Fig. 14-1. If you used three views what would you see? Yes, the front view and the top view would be exactly alike. Often it is not necessary to have three views for a good working drawing. This is almost always true of cylindrical shapes. Fig. 14-2. Many other objects can be drawn to show all needed information with only two views.

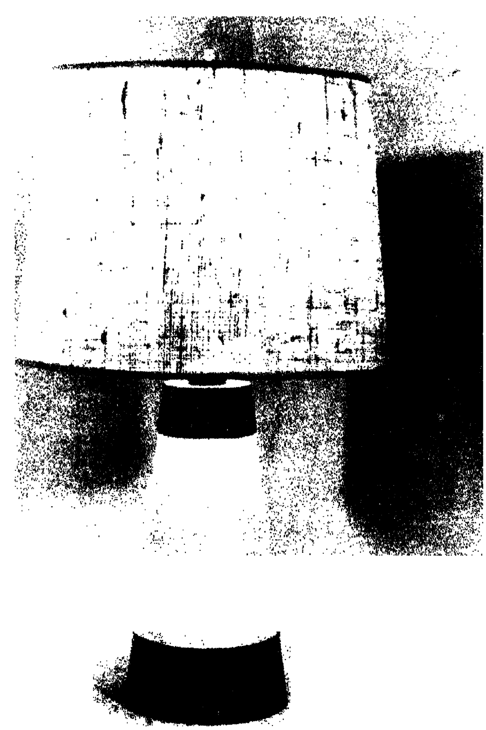
POINTS TO REMEMBER

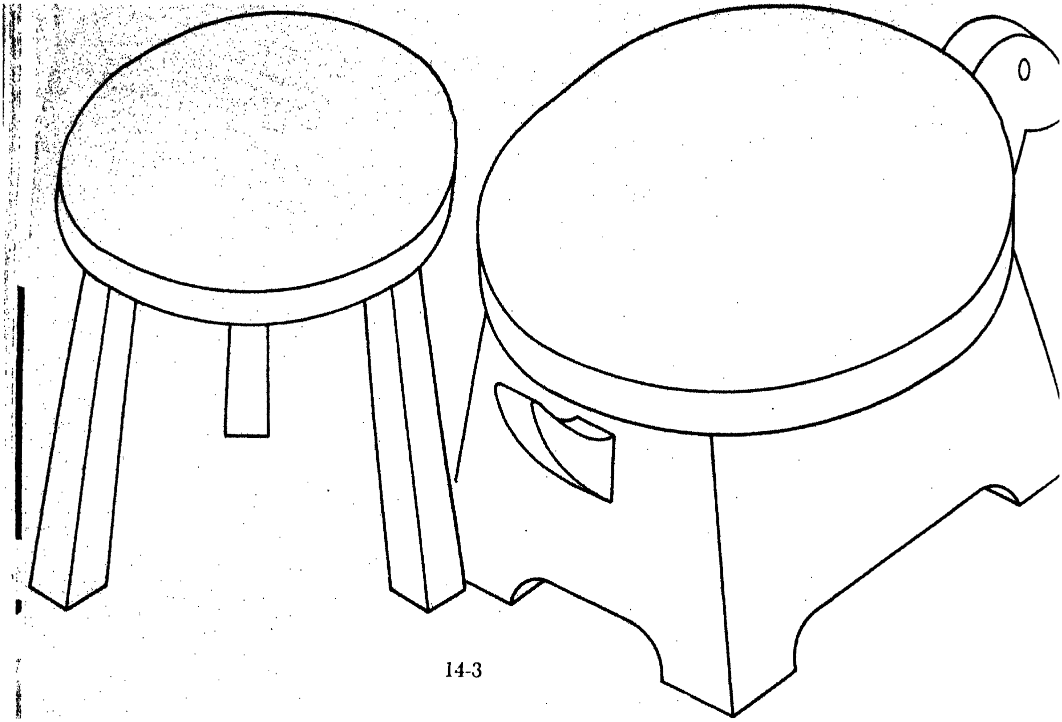
1. Always make the most distinctive view the front view. For example, suppose you are making a working drawing of the top of a footstool or small table. Fig. 14-3. You need only two views—one to show its shape and one to show the thickness. Fig. 14-4. Since the circular shape is the most important, this should be made the front view.

14-1. Two views of this rolling pin are alike. A two-view drawing, then, is all that is needed.

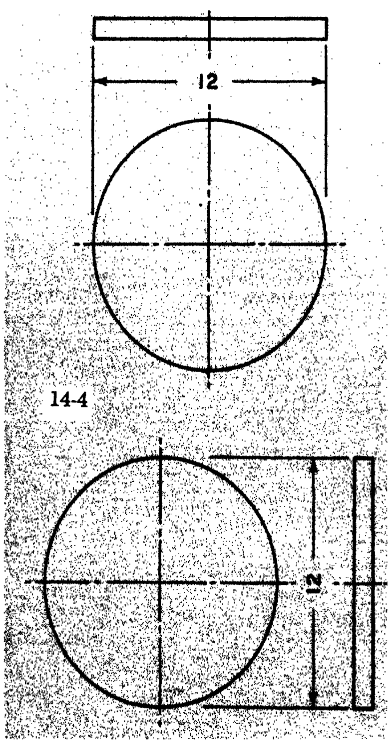


14-2. A lamp like this would require only two views. With a note, only one would be necessary.

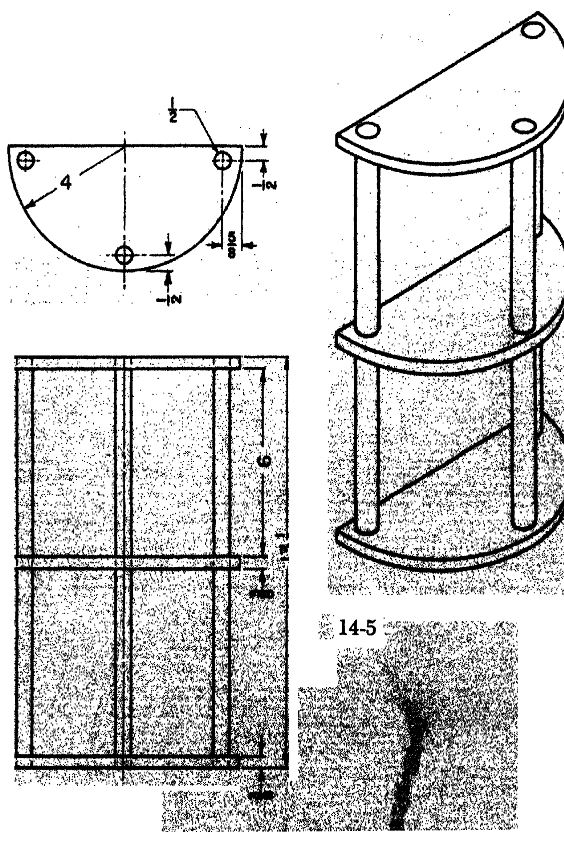




14-3



14-4



14-5

14-3. The top of a table or footstool would require only two views.

2. Draw a top or side view, which ever is best, as the second view. Fig. 14-4. Sometimes it is more convenient to use the top view and sometimes the side view is best.

3. Whenever possible use only two views even though three could be drawn. It is often a waste of effort and space to show the third view. This is especially true of woodworking drawings. For example, nothing new could be learned by making a side view of this small wall shelf. Fig. 14-5. All the information you need for making it is shown on the front and top views.

14-4. Two methods of drawing the top of a table or stool.

14-5. Would anything be added by drawing a third view of this wall shelf?

Section I

15. Making a Perspective Drawing

Drawing that looks most like a photograph is called *perspective* drawing. Perspective drawings are used by many different people. The architect makes a perspective of some new home or building he is designing. Note that with the artist's shading, the illustration is so lifelike that you might take it for a photograph of the finished building. Fig. 15-1.

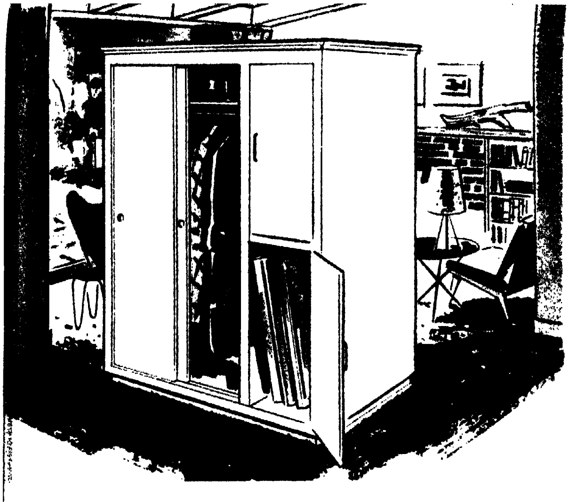
Perspectives are often used for illustrations in newspapers and magazines. Fig. 15-2. They can show what a future model car or plane looks like, for instance. Some industries use perspective drawings and sketches in construction. They are useful because the perspective shows the actual appearance and can be dimensioned with sizes.

Perspective drawings are made as the object appears to the eye. Note the photograph of the railroad tracks. Fig. 15-3. See how the tracks appear to come together at some distant point. This is called the *vanishing point* (V.P.). This point is on the *horizon*. Notice also that the things that are *below* eye level tend to move upward and get smaller toward the horizon. Objects *above* eye level, such as the telephone poles, tend to get shorter and move downward toward the horizon.

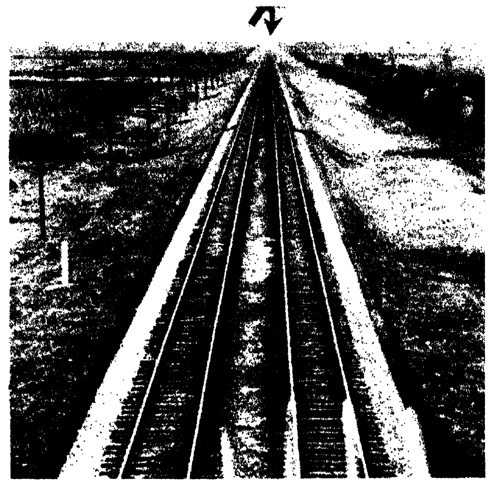
KINDS OF PERSPECTIVES

There are two kinds of perspective drawings—the *parallel* and the *angular*. The least used one is parallel perspective. It has one vani

15-1. A perspective drawing of a building. Notice how life-like it is.



15-2. A perspective drawing of a clothes cabinet. It is 6′ 8″ in height, 4′ deep, and 6′ long.



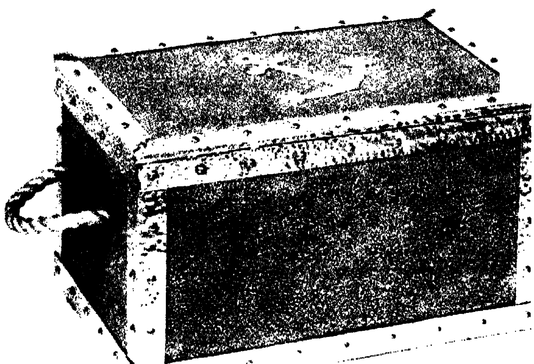
15-3. A photograph of a railroad track. Notice the vanishing point. What kind of perspective is it?

point and looks something like a cabinet drawing (see unit 17). Figs. 15-4 and 15-5. About 90 per cent of all perspectives are of the angular type. This has two vanishing points and looks something like an isometric drawing (see unit 16). To make a perspective drawing you will use a simple principle which is, that lines tend to come together and disappear at vanishing points on the horizon.

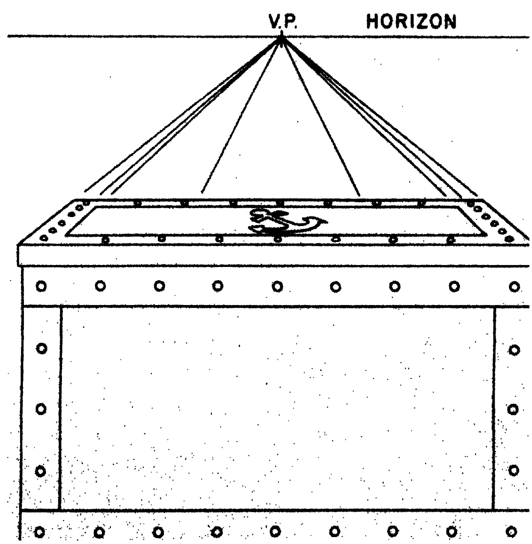
Perspectives can be made:

1. To appear below eye level, as though the object were on the floor and you were looking down at it. The object may be on center or to the right or left. Fig. 15-6.

2. To appear at eye level as though the object were on a table at eye height. The base may be on the horizon or the object centered on the horizon. Fig. 15-7. Fig. 15-8.

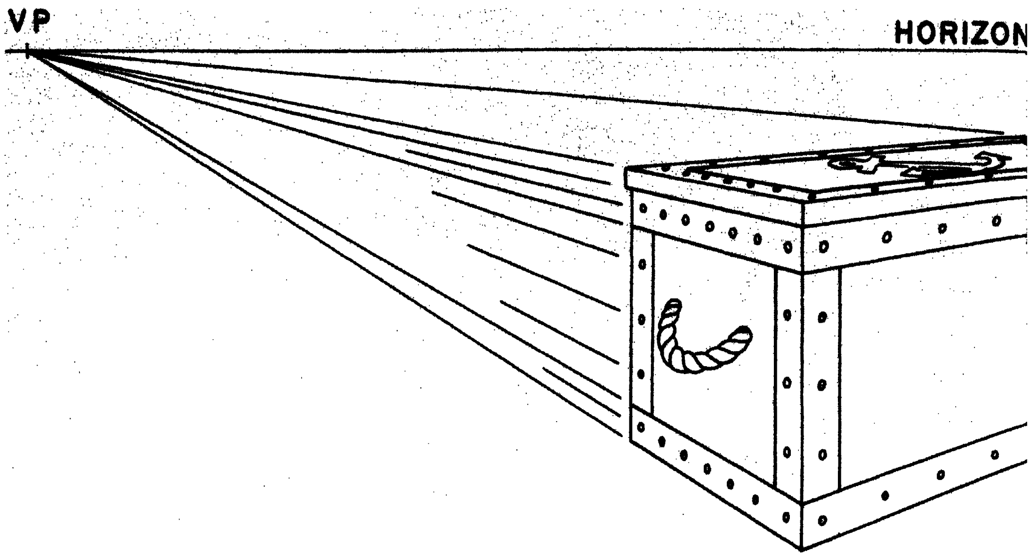


15-4

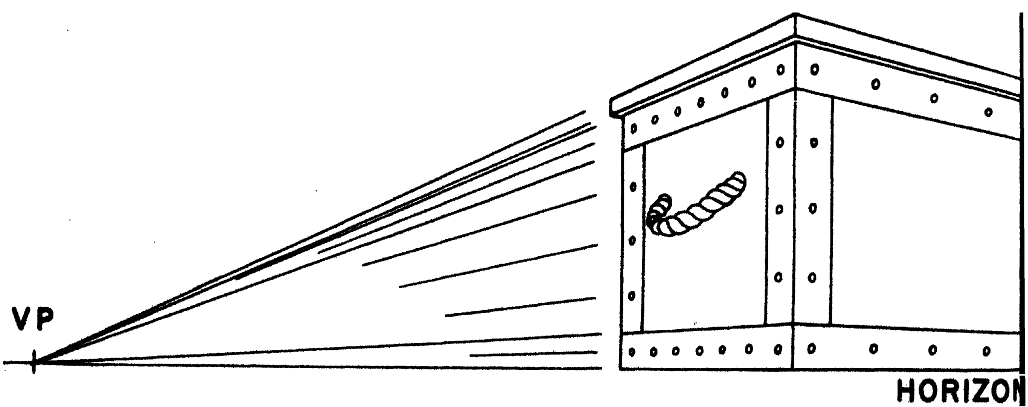


15-4. Here is a sea chest that we'll use to illustrate perspective drawing.

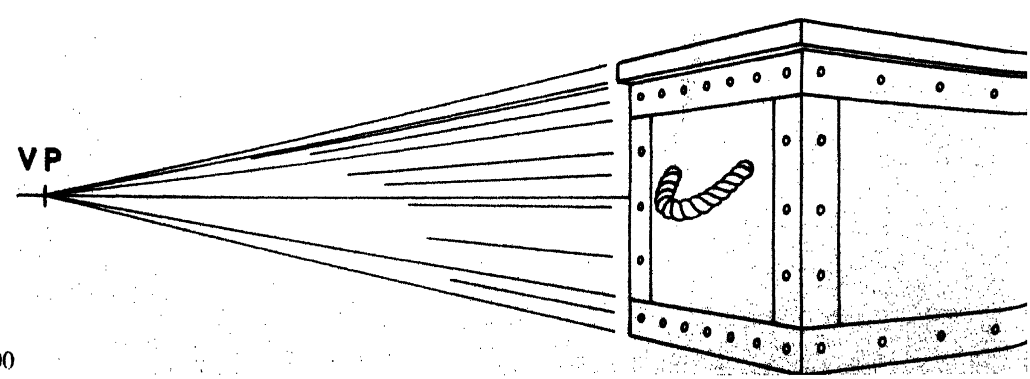
15-5. A parallel perspective of the sea chest.

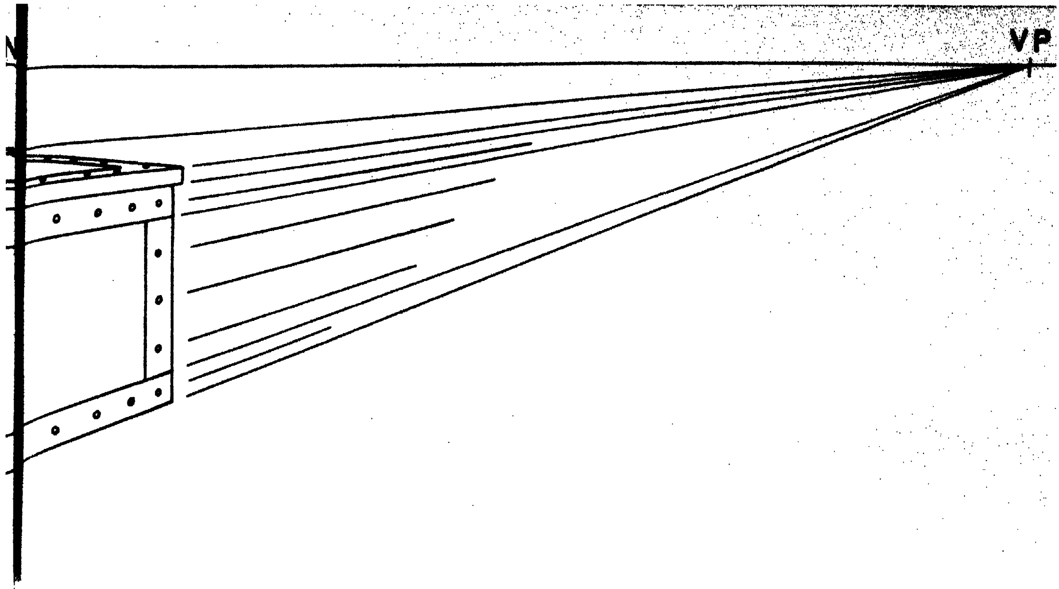


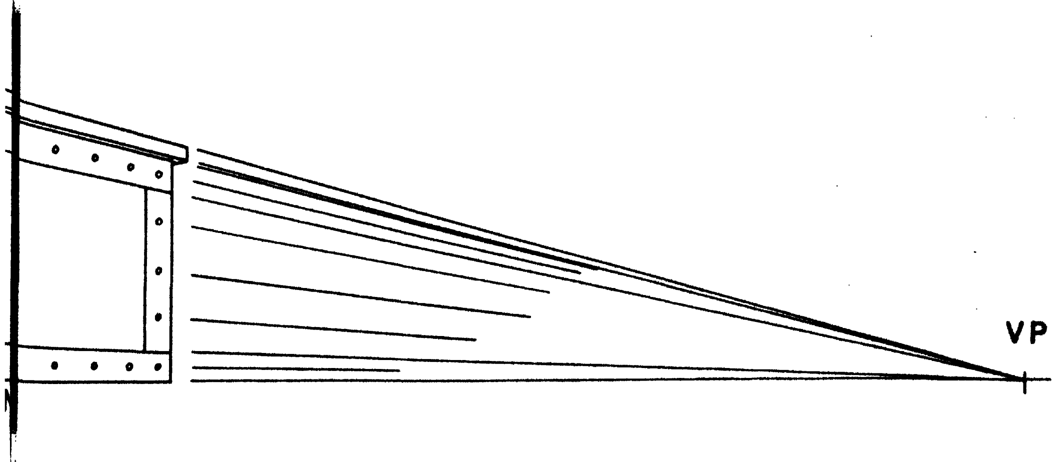
15-6. An angular perspective as it would appear below eye level.



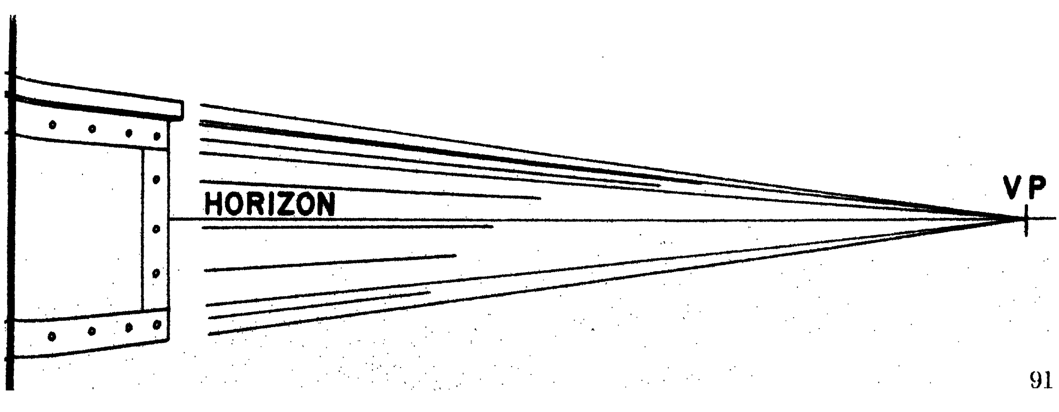
15-7. An angular perspective as it would appear with the base on the horizon.

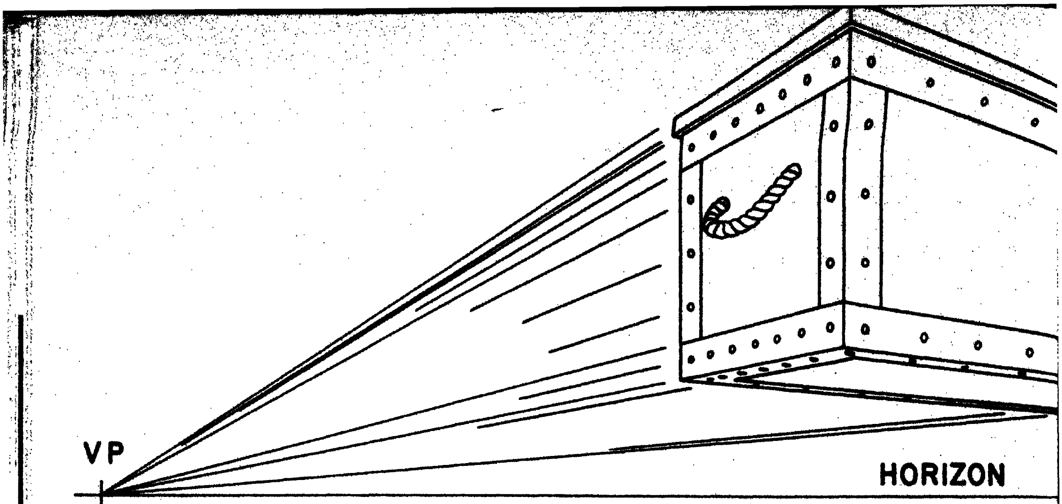






15-8. An angular perspective with the object centered on the horizon.





15-9. An angular perspective with the object above the horizon.

3. To appear above eye level as if the object were on a shelf. Fig. 15-9.

MAKING A PARALLEL PERSPECTIVE

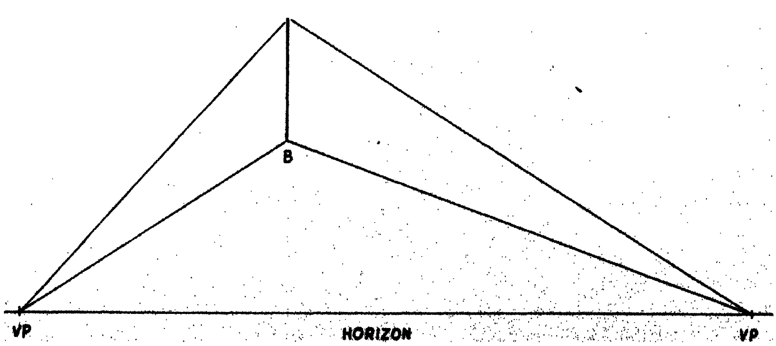
1. Draw a light line across the paper to represent the horizon line. If the object is to be drawn below eye level, place the horizon line about two thirds of the way up on the page. Mark a point on the line that will represent the vanishing point.

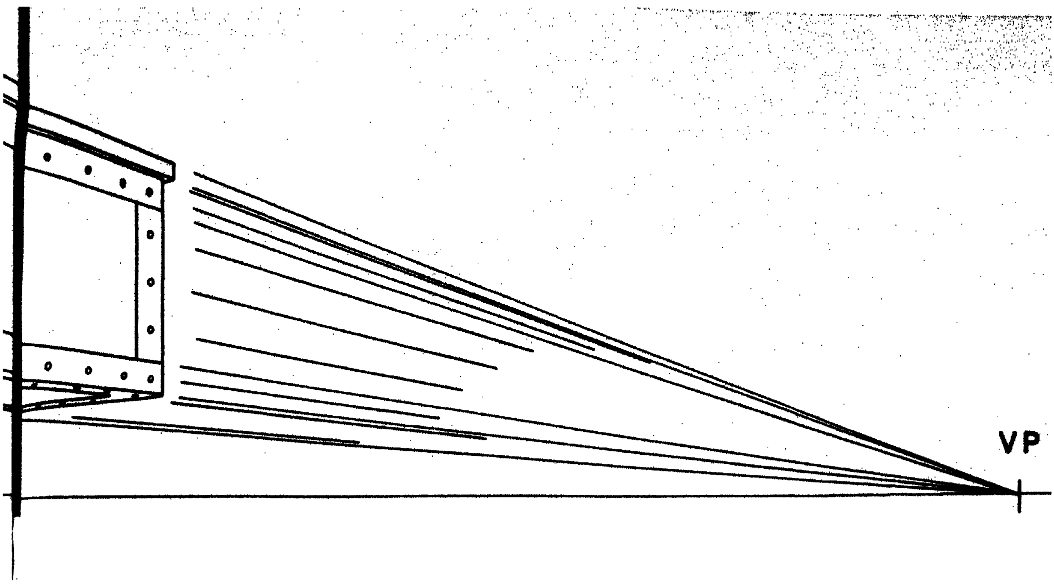
2. Draw the front view of the object as a true view either full size or to scale. This view would look exactly like the front view of a working drawing.

3. Draw light construction lines from the four corners of the front view to the vanishing point.

4. Determine the depth of the sides. This can be done by construction procedure but is quite difficult. Therefore, use the trial and error method to locate these points along the construction lines. Try several points until you find one that makes the object look about right. Darken in the lines to form the drawing.

15-10. The first step in making an angular perspective drawing. AB represents one corner of the box. Light construction lines are drawn from A to both vanishing points and from B to both vanishing points.





5. Hidden lines are not usually shown in perspective drawings.

MAKING AN ANGULAR PERSPECTIVE

1. Draw a light construction line across the paper to represent the horizon line. If the object is to be drawn above eye level, place the line about one third of the way up on the page.

2. Mark two points on the horizon to represent the vanishing points.

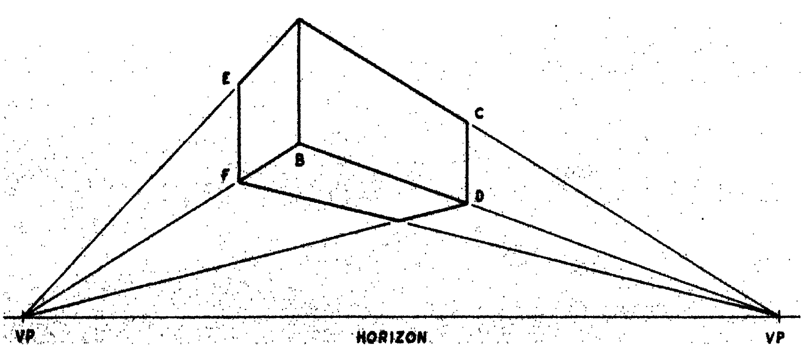
3. Draw a vertical line to represent one corner (thickness or height) of the object (AB). Fig. 15-10.

4. Draw construction lines from the ends of this line to both vanishing points.

5. Lay off the length of the object to the right (or left) of the first vertical line. Draw another vertical line at this point (CD). Lay off the width to the left (or right), and draw another vertical line (EF).

6. Draw construction lines from the bottom end (D and F) of these two lines to the vanishing points. Darken in the lines to complete the view. Fig. 15-11.

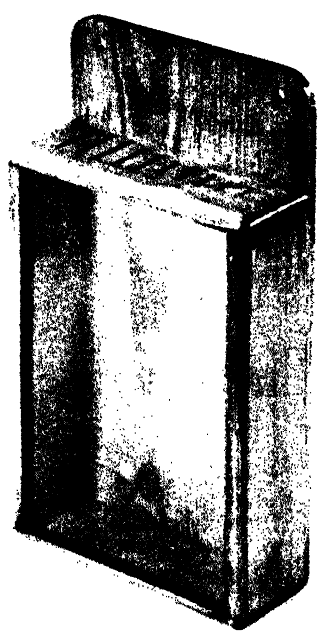
15-11. Completing the angular perspective drawing. ABCD represent one side of the box. ABFE represent another side.



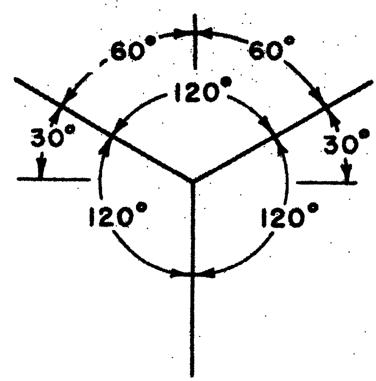
16. Making an Isometric Drawing

An isometric drawing is a picture drawing. One corner of the object appears closest to you. Fig. 16-1. The lines that form the sides are 120 degrees apart. Fig. 16-2. Isometric means "equal angle." Do you see why?

An isometric drawing is used primarily for objects that are rectangular in shape. Fig. 16-3. In a single view it provides both a picture of the object and a place to dimension it. Fig. 16-4.



16-1. The photograph of this knife rack looks much like an isometric drawing. One corner (see arrow) is closest to you.

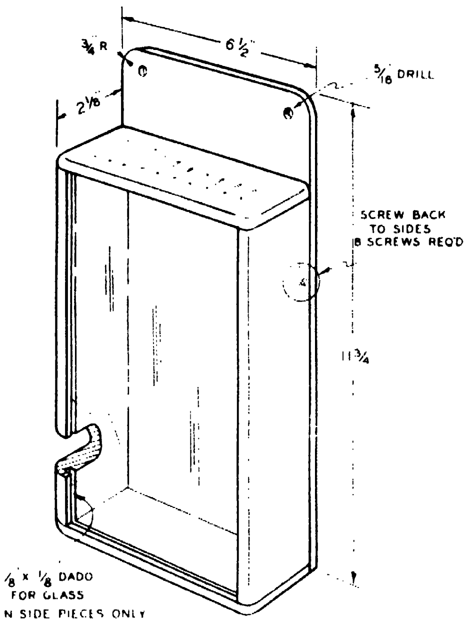


16-2. The three lines used as a base for constructing an isometric. Notice that they are 120 degrees apart. Two lines are drawn at an angle of 30 degrees to the horizontal.

Making an Isometric Drawing. Let's make a simple drawing of a rectangular shaped object such as a basketball bankboard. Fig. 16-5.

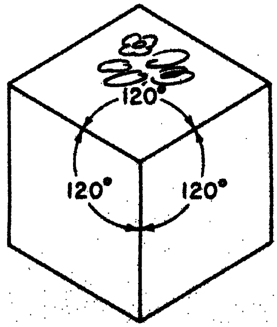
1. Draw a light horizontal line. Fig. 16-6. Draw a vertical line to represent one edge of the object (width AB). Fig. 16-5.

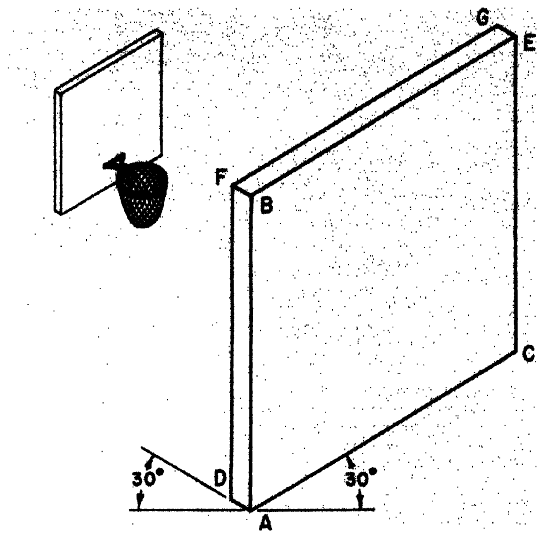
2. (a) Draw lines to right and left at an angle of 30 degrees to the horizontal. (b) Mark off AC to represent the length of the bankboard and AD to represent thickness.



16-3. An isometric drawing of the knife rack. The sizes are ½" x 2⅞" x 8½". The top and bottom are ⅜" thick. The back is ¼" in thickness.

16-4. An isometric drawing of a simple plastic paper weight. Each side is drawn its true length.

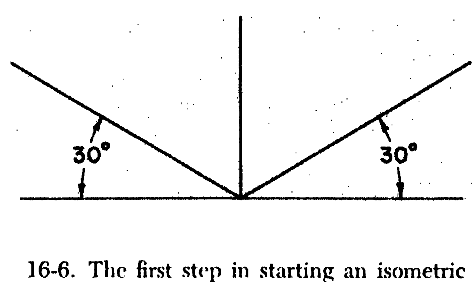




16-5. An isometric drawing of a basketball bankboard.

3. Draw vertical lines CE and DF.

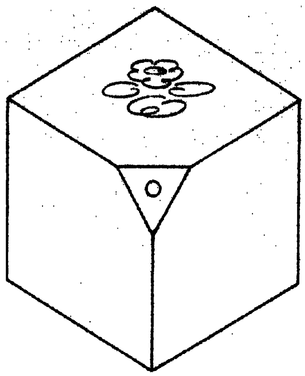
4. Now, with your 30-60 degree triangle, complete the outline by drawing lines BF, BE, FG, and EG. Notice that all of these lines are drawn their true length since they are what is called isometric lines.



16-6. The first step in starting an isometric drawing.

5. Hidden or invisible lines are not usually shown on isometric drawings.

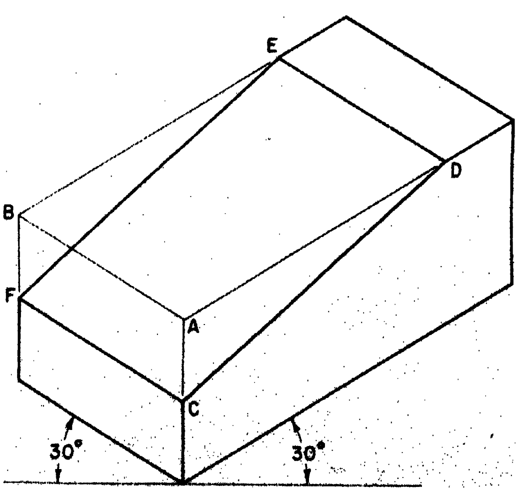
Non-Isometric Lines. Many objects are not true rectangles. For example, the plastic pen holder shown



16-7. This plastic pen holder has several
Whic tl

in Fig. 16-7 has one corner cut off for the pen hole. To make a drawing of this kind it is necessary to enclose the object is an "isometric box." Fig. 16-8. Measure from the corner A and B and mark the location of the slanted lines (F and C). Connect points FC, CD, FE and ED. Lines CD and FE will not be true length. They are called *non-isometric lines.* They are not true in length. Non-

16-8. To draw non-isometric lines, the object must be enclosed in an isometric box.



isometric lines must be drawn by locating the ends of the lines on isometric lines and connecting the points with a straightedge.

Drawing Circles in Isometric. A circle in isometric is really an oval or an ellipse. For this reason the isometric drawing is not the best one for objects that are circular in shape. However, to draw a circle in isometric, proceed as follows:

1. Draw a square in isometric, ABCD. Fig. 16-9.

2. Divide the sides in half and mark these points E, F, G, and H.

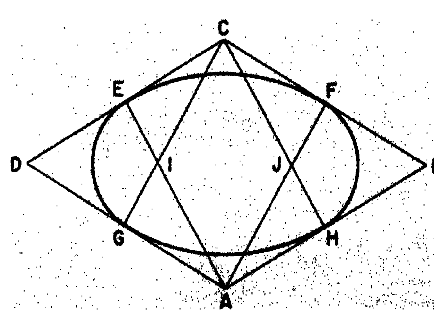
3. Draw light construction lines AE, AF, CG, and CH. Mark the points of intersection I and J.

4. Adjust a compass to a radius equal to JF. Place the point of the compass at J and draw the arc FH. Place the point of the compass at I and draw the arc EG.

5. Adjust the compass to a radius of AE. Place the point of the compass at C and draw the arc HG. Place the point of the compass at A and draw the arc EF. This will complete the isometric circle. If necessary, erase the construction lines.

Exploded Isometric. A type of isometric drawing that is particularly useful for construction or for assembling parts is called an exploded iso-

16-9. Drawing a circle in isometric.



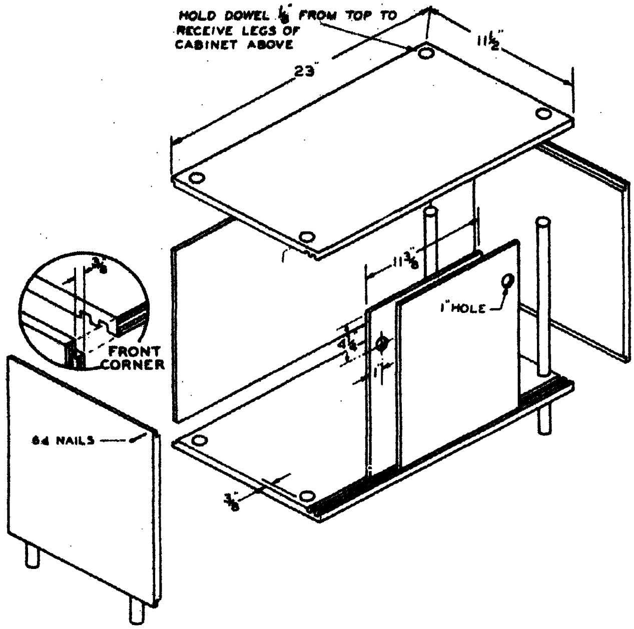
16-10. Here are some stacking cabinets drawn as an exploded isometric in Fig. 16-11.

metric. It is valuable because it shows each part in greater detail. It also shows how the whole thing goes together. Look at the exploded isometric of stacking cabinets in Figs. 16-10 and 16-11, and see how each dimension is clearly shown. You can also see how each part must be put together to make the assembly.

Irregular Curves in Isometric. If part of the object to be drawn in isometric contains irregular curves, proceed as follows:

Make a one-view drawing of the irregular surface on squared paper. Mark the vertical and horizontal lines with letters and numbers as you would for enlarging a pattern. Now draw an isometric box, with one face of the box covered with squares. Transfer the points from the view drawing to the isometric box until enough points are secured. Then use a French curve to draw the curves. Fig. 16-12.

Angles in Isometric. To lay out

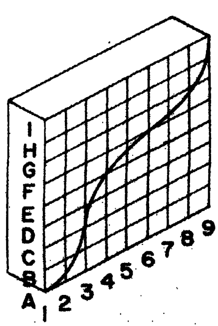


16-11. An exploded isometric drawing of the stacking cabinets. See how easy it is to read the dimensions and follow the construction details.

an angle in isometric, do the following:

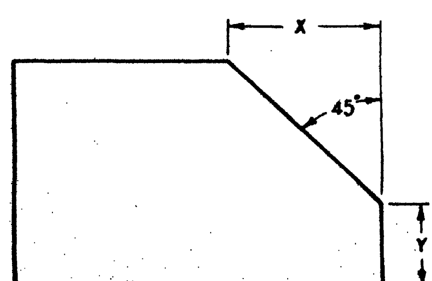
Make a one-view drawing showing the angle. Draw an isometric box. Transfer the actual measurements (X and Y) from the view drawing. Draw the angle. Fig. 16-13.

16-12. Drawing a curve in isometric. The curve is first drawn as a one-view drawing and then the points transferred to the isometric box. A French curve is needed.



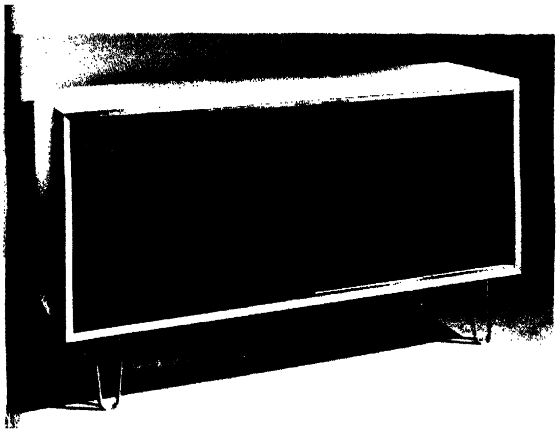
Dimensioning in Isometric. The same general rules for dimensioning working drawings are followed in isometric. The dimension lines should always be parallel to the object lines. The extension and dimension lines should be outside the object whenever possible.

16-13. Drawing an angle in isometric.



Section I

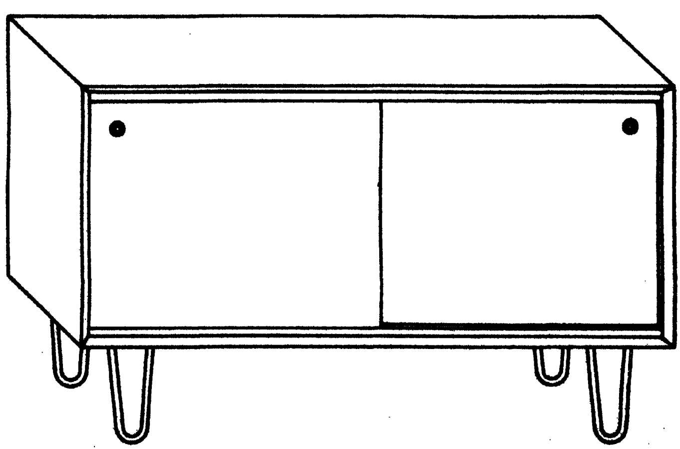
17. Making An Oblique or Cabinet Drawing

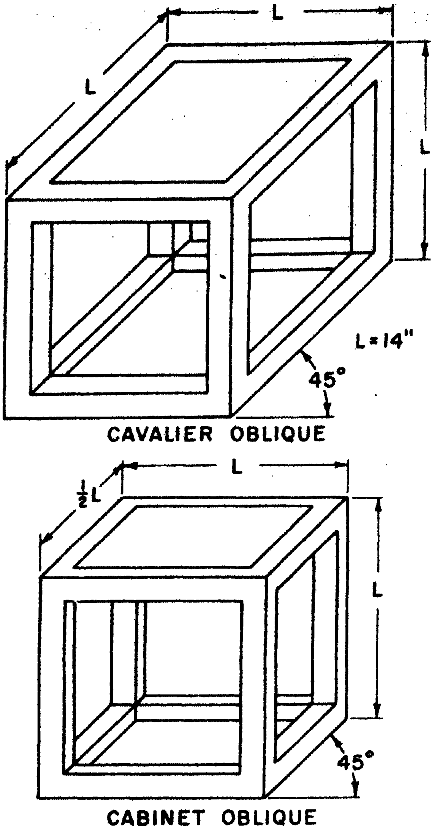


Another type of picture drawing is called an oblique drawing. Fig. 17-1. Oblique means "slanting" or "inclined." That's exactly what the drawing is. One side of the object appears closest to you. The top and right or left side slant away from you. Fig. 17-2. One kind of oblique is

17-1. This dining room chest is typical of the kind of object best shown as a cabinet drawing.

17-2. A cabinet drawing of the dining room chest. The size is 18½″ deep, 24″ high, and 53³⁄₁₆″ long.





17-3. A cube drawn as a cavalier oblique and as a cabinet oblique. Which looks more like a cube? This is a good illustration of optical illusion.

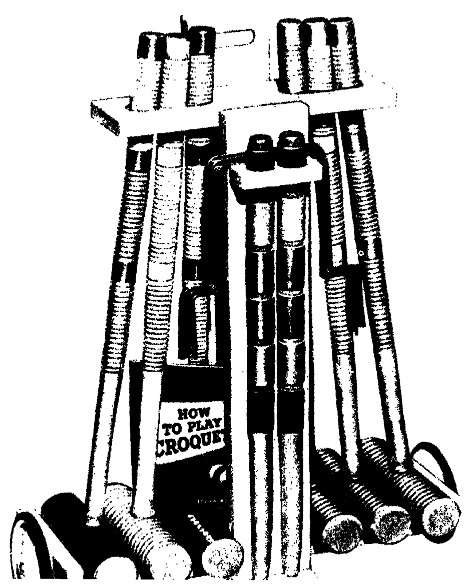
called *cabinet* because it is the favorite of the cabinet maker. It's an excellent kind of picture drawing for rectangular cabinets, chests, and tables.

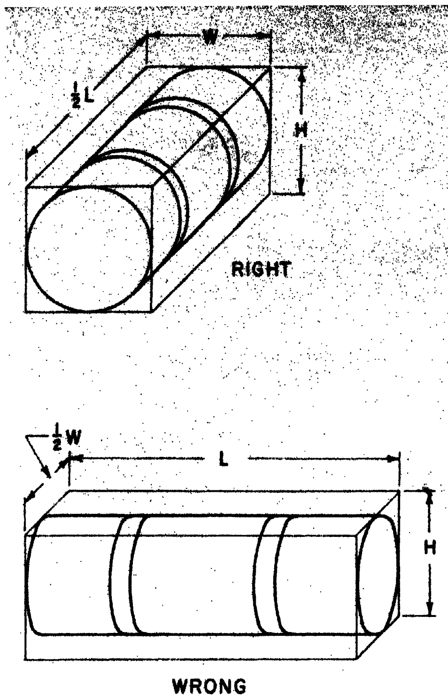
If an object is a true rectangle, the front side is drawn exactly as a working drawing. This surface is shown by vertical and horizontal lines of true length. The other surfaces are formed by drawing inclined lines at an angle of 30 to 45 degrees, but usually 45 degrees, to the right or left.

Kinds of Oblique. The two kinds of oblique drawings are *cavalier* and *cabinet*. In a *cavalier* drawing the true lengths of the side and top are measured off along the inclined lines. Notice, in Fig. 17-3, that this looks to the eye as if the top and side are longer than they really are. For this reason the cavalier drawing is seldom used. In the *cabinet* drawing this is corrected. Fig. 17-3. Half the true length is measured off on the inclined lines to complete the drawing. The correct dimension, however, is always given. Notice the difference.

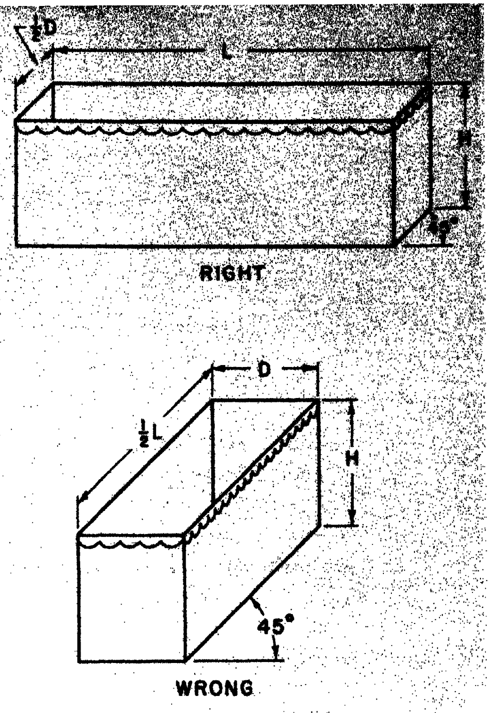
Points to Remember. 1. If a cabinet drawing contains circular parts, always draw the circle on the surface that appears nearest you. Fig. 17-4. It will then be a true circle in size and shape. For example, to draw the head of a croquet mallet, make the circle a part of the side nearest

17-4. To draw the head of the croquet mallet, it would be best to draw the circle on the front side.





17-5. The right and wrong way to draw the head of the croquet mallet.



17-6. The right and wrong way to draw a long flower box. Notice that the long side is a part of the surface nearest you.

you as shown in Fig. 17-5. Circles on the top or right or left surface would be ellipses, as in isometric drawings.

2. If a long object, such as this window box, is drawn in cabinet, always place the long side as part of the surface nearest you, never short side. Fig. 17-6. Notice that rules 1 and 2 sometimes clash. If they do, the first rule is the more important. The croquet mallet is an example.

3. To make a cabinet drawing that is above eye level, such as this high kitchen cabinet, Fig. 17-7, draw the inclined lines down at an angle of 45 degrees, instead of up.

To make a cabinet drawing proceed as follows:

1. Select the side that makes the best front surface.

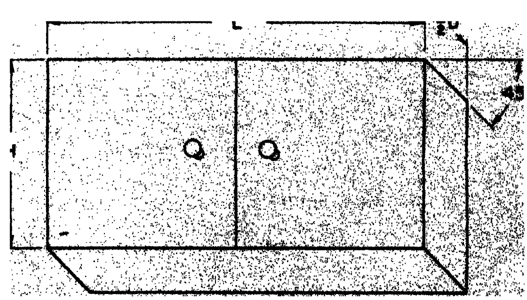
2. Draw this as you would the front view of a working drawing.

3. Draw inclined lines from the front view at an angle of 45 degrees to the right or left to form the top and side.

4. Lay off *only half the true length* on these inclined lines.

5. Draw the horizontal and vertical lines from these points to complete the outline of the object.

17-7. A kitchen cabinet above eye level would be drawn as shown here.



Section I

18. Detail and Assembly Drawings

How many parts are there in a bicycle? There certainly are many. While planning to manufacture this bicycle, a drawing had to be made for each part. This *detail drawing* showed the exact shape, the dimensions, and any other information necessary to manufacture the part. An *assembly drawing* was also needed to show how each of these parts fits to the next piece to make the completed bicycle.

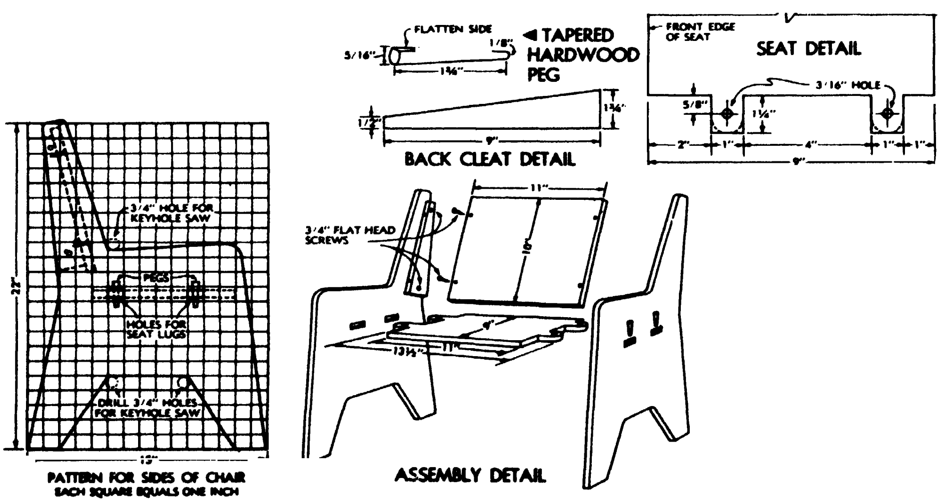
Working drawings are of two kinds—*detail* and *assembly*. Assembly drawings show how the parts go together. These vary a great deal in the amount of information included. A detail drawing always gives all of the information necessary to construct that particular part.

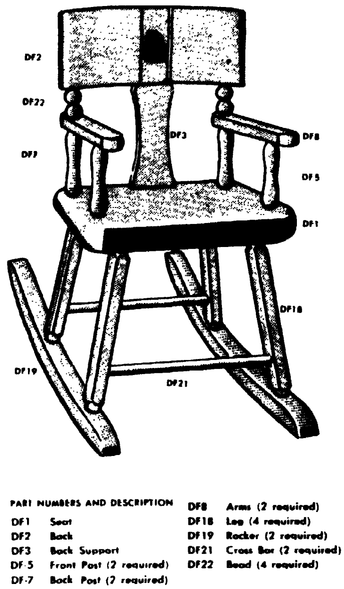
KINDS OF ASSEMBLY DRAWINGS

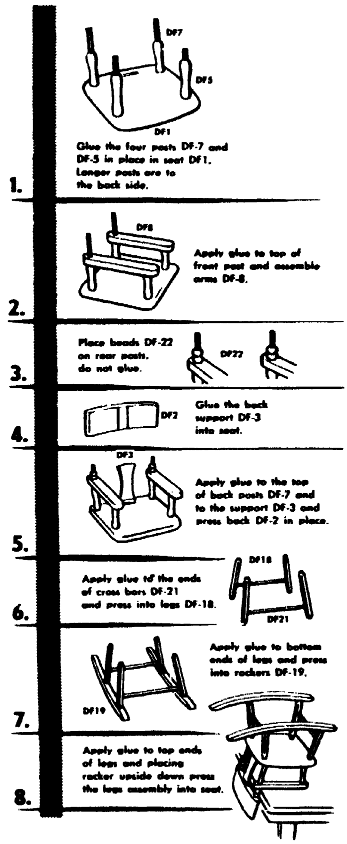
There are several kinds of assembly drawings. Each has a particular purpose. Some of the most common are:

1. Working assembly drawings. This type gives complete information on how to make each part and

18-1. A working assembly drawing for a child's chair. Notice that there is complete information given on how to build and assemble it





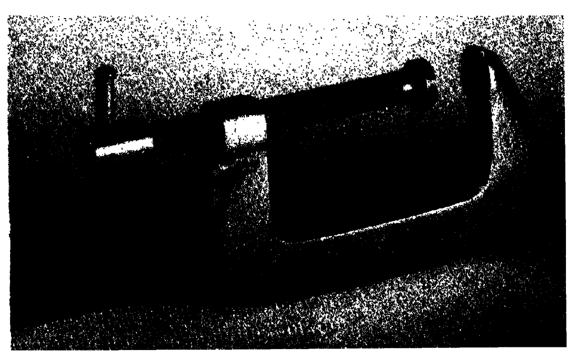


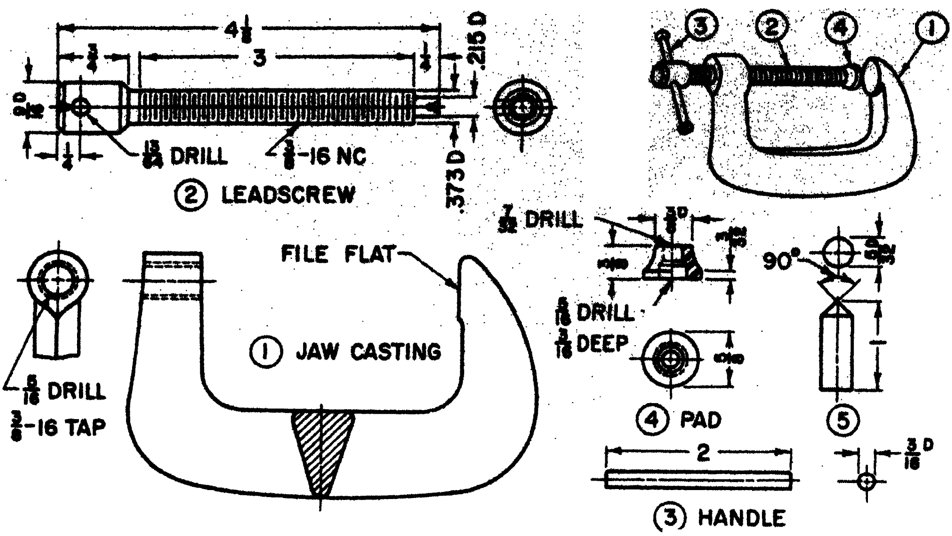
18-2. An outline assembly drawing showing how a rocking chair would go together. This is the kind of drawing you usually get when you order something by mail. It shows you how to assemble the object.

how it fits with the next part. For example, most woodworking drawings are working assembly drawings. These are usually *view* drawings although *pictorial* drawings might also be used. Fig. 18-1. One drawing includes all the information necessary for the builder.

2. Outline assembly drawings. This is a simple outline drawing of the assembly showing how the parts go together. Fig. 18-2. It may be either a pictorial or view drawing. Its main purpose is to show how to put the object together. This type is often used with detail drawings. For

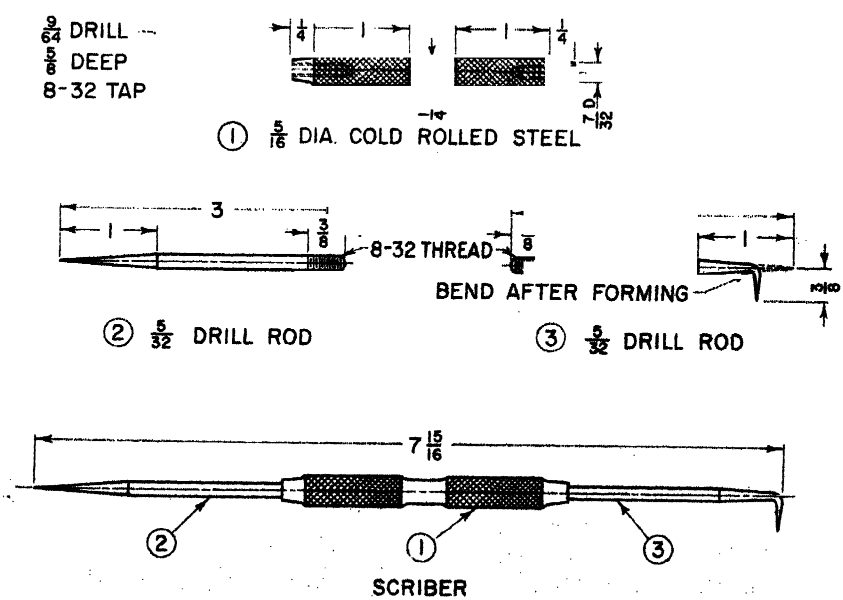
18-3. The completed C clamp. The detail and assembly drawings are shown in Fig. 18-4.





18-4. A detail drawing of each part of the C clamp. Notice that the assembly drawing is numbered and the numbers are shown beside each of the detail drawings. See project source No. 2 in appendix.

18-5. Another example of a combination of detail and assembly drawings.

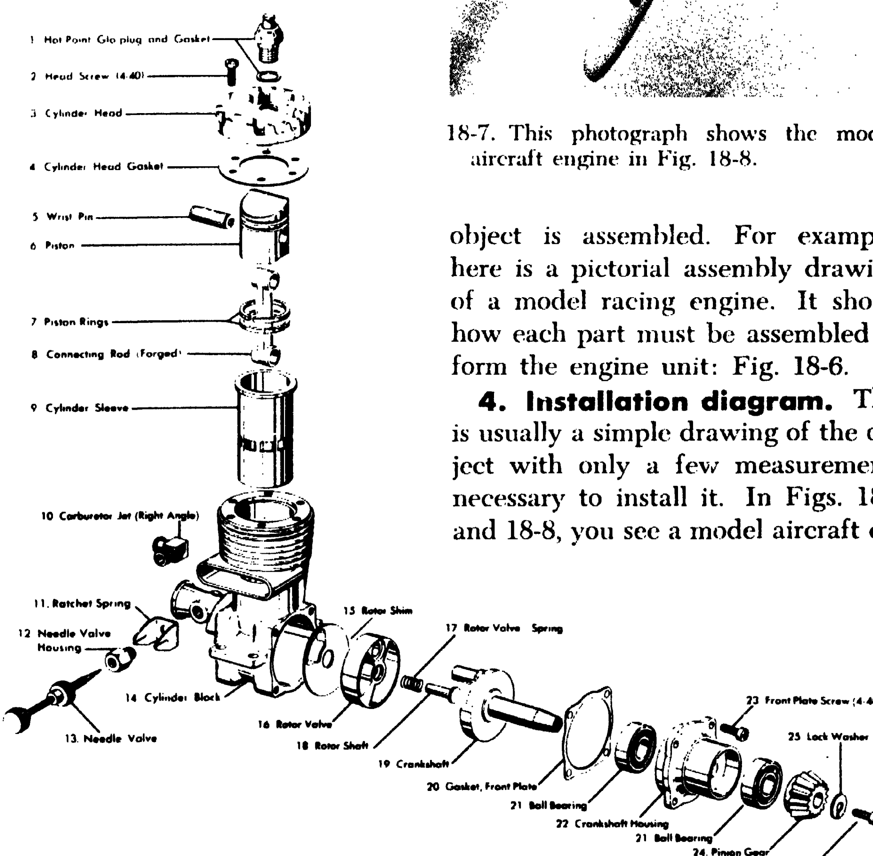


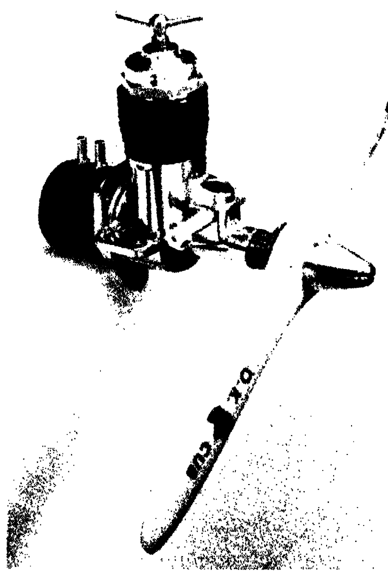
example, to make the C clamp, Fig. 18-3, a pictorial assembly drawing and detail drawings of each part are provided. The parts are usually numbered or lettered and the same numbers or letters placed near each of of the detail drawings. Figs. 18-4 and 18-5.

3. Sub-assembly drawings. This shows how a part of a larger object is assembled. For example, here is a pictorial assembly drawing of a model racing engine. It shows how each part must be assembled to form the engine unit: Fig. 18-6.

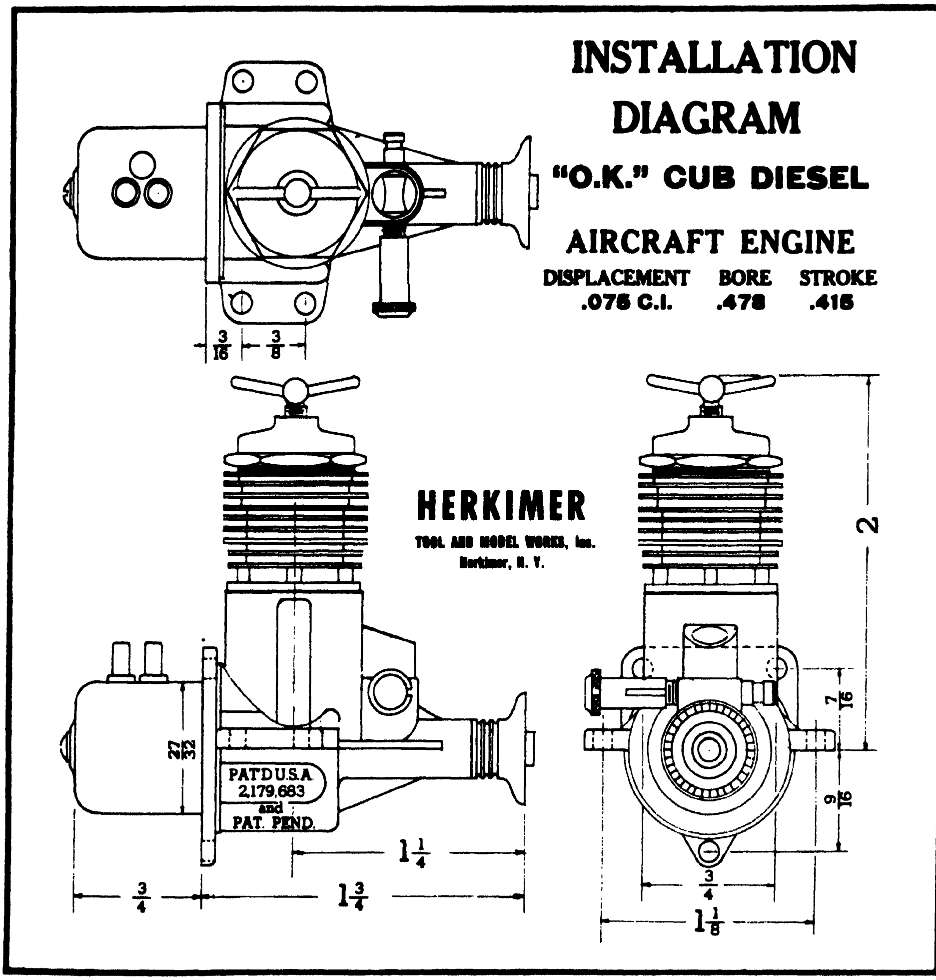
4. Installation diagram. This is usually a simple drawing of the object with only a few measurements necessary to install it. In Figs. 18-7 and 18-8, you see a model aircraft en-

18-6. An exploded pictorial assembly drawing. Each part is clearly shown so that the object could be assembled. It is also used in company catalogs with parts lists. This type of drawing is good for those people without experience in drawing.





18-7. This photograph shows the model aircraft engine in Fig. 18-8.



18-8. This installation diagram is needed to build a model airplane in which this engine might be installed.

gine-propeller and an installation diagram. Enough information is given to make it possible to install the engine in a model plane.

DETAIL DRAWING

A detail drawing shows everything about a single part that is necessary to build or make it. It must include the exact shape, the exact dimensions, and any other information needed about the kind of material to use, the finish, and other details.

In making a detail drawing there are several suggestions for completing it:

1. If the object contains several

detail drawings, make each of them to the same scale. If the part is very small, make the detail drawing double size.

2. Place the detail drawings on the page so they are convenient to read.

3. Place the dimensions on each so they can be read without crowding.

4. Select the views that will show the detail best. Use only enough views to show it well. Sometimes one is enough and at other times two or three are needed to show everything.

5. "Block in" the drawing with light construction lines.

6. Complete the detail drawing, including all necessary information. If the object is small and contains few parts, both the detail drawing for each part and the assembly drawing may be shown on the same page.

A complete set of working drawings for a large object will include several assembly drawings and as many detail drawings as there are parts of the object.

PROBLEMS—SECTION 1

Section 1—QUESTIONS AND TOPICS FOR DISCUSSION

1. What are some of the ways you use drawing every day?
2. Why is drawing an important part of our industry?
3. What is a rule? Describe how to use it.
4. What equipment is needed for beginning drawing?
5. How are pencils graded? Which is harder, a 3H or an HB?
6. How are triangles used to draw vertical lines? Slanted or inclined lines?
7. What is an acute angle? A right angle? An obtuse angle?
8. What tool is needed for drawing circles and arcs? Describe how it is used.
9. What is a one-view drawing? Can you name some examples of one-view drawings?
10. What are dimensions?
11. Give the meaning of these three kinds of dimensions: (a) overall dimensions, (b) position or location dimensions, (c) detail dimensions.
12. What are extension lines? Dimension lines?
13. Explain why lettering is a kind of freehand drawing.
14. Why are some letters given more space than others? What is meant by open and closed letters?
15. Explain the information that goes into a title block or record strip.
16. What does it mean to make a drawing to scale?
17. What is a pattern used for? How can you get patterns?
18. Explain how to enlarge a pattern by the squared paper method.
19. What is a working drawing?
20. What are the three main views used in a working drawing?
21. Tell what determines the number of views to use for a drawing.
22. When is it necessary to use invisible or hidden lines?
23. What is a perspective drawing? Where is it best used?
24. How is an isometric drawing made?
25. What are the kinds of oblique drawings?
26. Where are cabinet drawings used a good deal?
27. What are assembly drawings? Detail drawings?

Section I—SELF-CHECKING WHAT YOU HAVE LEARNED

PART I. True-False: Place a "T" after the sentence if it is true and an "F" if it is false. *(Number separate sheets for this test. Do not write in your book.)*

SAMPLE: *Drawing is a method of explaining by using pictures instead of words. T*

1. A pictorial drawing looks very much like a photograph.
2. The drawing most useful to the workman and builder is the perspective drawing.
3. There is little use in learning drawing unless you plan to become a draftsman.
4. A 4H pencil is harder than a 2H pencil.
5. One triangle used in drawing has two 45-degree angles and one 90-degree angle.
6. The T square and a triangle are used to draw vertical lines.
7. The T square should be used with the head held against the top of the drawing board.
8. The radius of a circle is one half its diameter.
9. The diameter of a circle is the length of a straight line through the center.
10. A line that is tangent to a circle crosses through the circle.
11. A border is always used on every kind of drawing.
12. Drawing should be centered on the paper.
13. Dimension lines are light solid lines with a space in the middle and arrowheads at one or both ends.
14. The lightest lines on the paper are the border lines.
15. Extension lines should start about ½" away from the outline of the object.
16. Arrowheads should be drawn about three times as long as they are wide.
17. Always dimension the radius of circles and holes.
18. Notes on a drawing are usually lettered in ½" capitals.
19. Lettering is a kind of freehand drawing of letters and numbers.
20. A scale of ½" equals 1' means that the drawing is made twice the size of the object.
21. Patterns can be enlarged by using squared paper.
22. An invisible or hidden line is a series of dashes about ⅛" long with white spaces between.
23. A perspective drawing is very lifelike.
24. In an oblique drawing one corner appears closer to you.
25. In a cabinet drawing the lines to form the top and sides are made twice the true length.
26. In a working drawing the height is shown on the front and right-side view.
27. In a working drawing the length is shown on the front and right-side view.
28. Only two views are necessary to make a working drawing of a round hockey puck.
29. A leader to a hole should be drawn at an angle of 45 or 60 degrees to the horizontal.
30. The diameter of an arc should be dimensioned.

PART II. Fill In: Add the word or words to complete the sentence. *(Use separate sheets for this test. Do not write in your book.)*

SAMPLE: *The two parts of a T square are the head and the blade.*

1. Drawings are used as illustrations or

2. The four kinds of drawings are-

-, and-

3. The symbol for inches is——— and

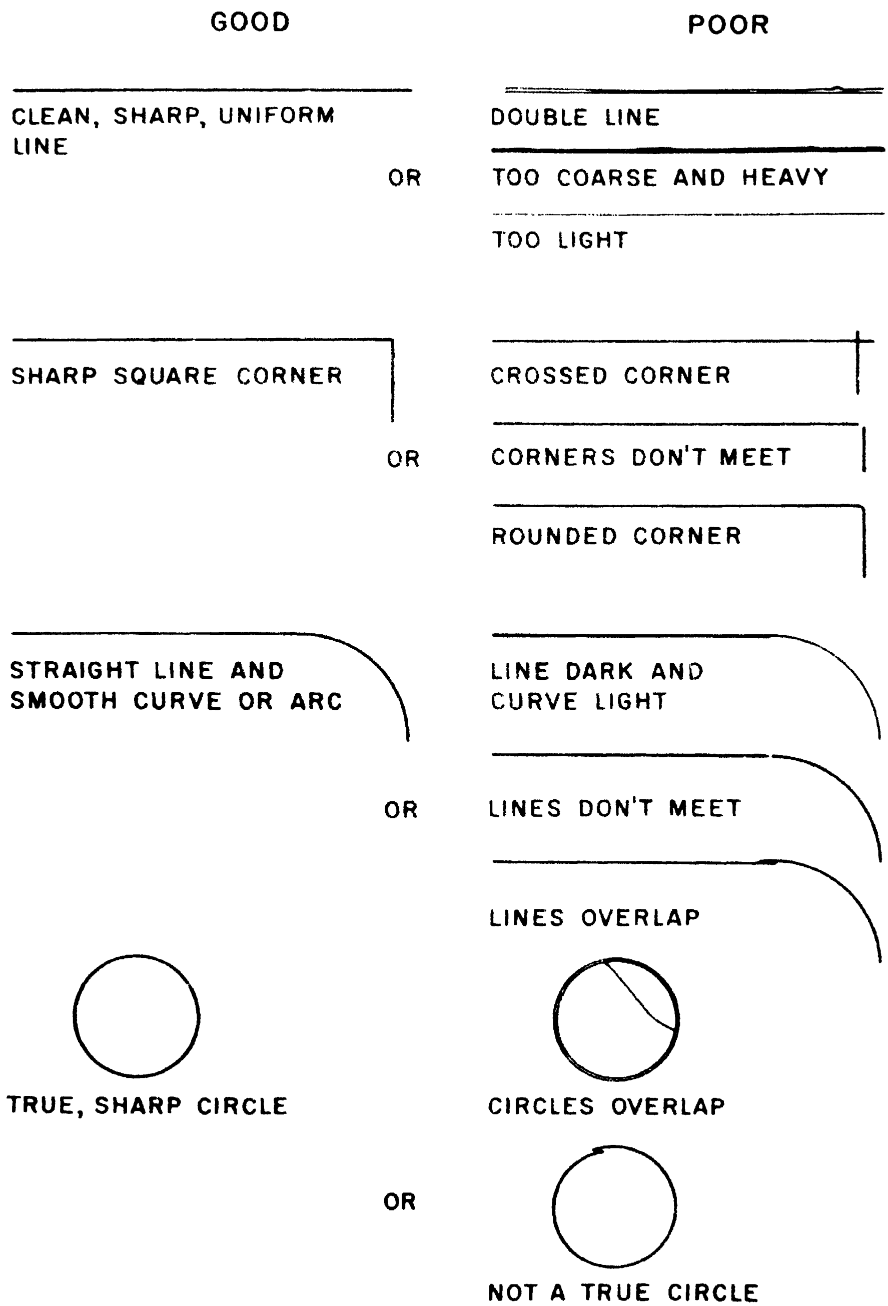
for feet————.

4. The measuring system for feet, yards

and inches is called the———— system.

5. The two triangles you will use in

Self-Check Your Line Work



drawing are the——— and the———.

6. Drawings are done at a drawing bench or on a———.

7. Horizontal lines are drawn with

8. Vertical lines are drawn with a- and a-

9. Paper can be fastened in place with thumb tacks or———.

10. An obtuse angle is one that is——— than 90 degrees.

11. A metal or plastic tool used to lay out odd angles is called a———.

12. Circles are drawn with a———.

13. Information about the drawing and who made it is placed in the——— or record strip.

14. Lines that show the shape of the object are called object or——— lines.

15. Lines that extend out from the object and are used in dimensioning are called ——— lines.

16. Letters of the alphabet are made up of circular, horizontal, vertical and——— lines.

17. On most drawings letters are made about——— high.

18. A line used to show a surface or edge that cannot be seen is called——— or

19. Most perspective drawings are made as——— or two-point perspectives.

20. A circle in isometric is drawn as or———.

21. Working drawings are——— and assembly drawings.

PART III. Multiple Choice: Read each statement and decide which is the correct answer. There is only one right answer. List them on separate paper.

SAMPLE: *Lines at right angles to each other form an angle of (a) 45 degrees, (b) 90 degrees, (c) 60 degrees.*

1. The three views commonly used in a working drawing are (a) front, top and bottom, (b) front, top and left side, (c) front, top and right side.

2. The number of views needed in a working drawing depends on (a) the size of the object, (b) the shape of the object, (c) the method of drawing the object.

3. The view that best shows the shape of the object should be made the (a) top view, (b) front view, (c) right-side view.

4. The views of a working drawing should be arranged so that there are the least number of (a) invisible lines, (b) curved lines, (c) straight lines.

5. The two dimensions shown on the front view of an object are (a) height and width, (b) height and length, (c) width and length.

6. The two dimensions shown on the right-side view are the (a) height and width, (b) height and length, (c) width and length.

7. The shape of an object is shown by the (a) views, (b) dimensions, (c) notes.

8. Invisible or hidden lines are made up of dashes (a) 1/16" in length and spaced 1/8" apart, (b) 1/8" in length and spaced 1/32"

Self-Check Your Lettering

GOOD		POOR
ALWAYS USE GUIDE LINES	OR	POOR EGBERT NO GUIDE LINES
FORM EACH LETTER CORRECTLY	OR	MY 8'S LOOK LIKE B'S LETTERS BACKWARD LIKE P, S, Z, N, L
KEEP ALL LETTERS AT THE CORRECT SLANT	OR	YOU'VE GOT THE WRONG SLANT
WATCH YOUR CURVED LETTERS	OR	MY POOR CURVES
SPACE LETTERS AND WORDS TO LOOK RIGHT	OR	EACH LETTER AND WORD IS EQUALLY SPACED
LETTER NUMBERS CORRECTLY AS TO SHAPE AND SIZE $8\frac{1}{2}+3\frac{1}{2}=12$	OR	THESE NUMBERS ARE WRITTEN $8\frac{1}{2}+4\frac{1}{2}=13$ THE FRACTIONS ARE TOO SMALL AND TOO LARGE
USE ALL UPPER CASE LETTERS TOGETHER	OR	UppeR ANd LowER CaSES MiXed Up

I-A-B

apart, (c) $\frac{1}{8}$" in length and spaced $\frac{1}{8}$" apart.

9. Dimensions are added to a working drawing so that (a) you can see the size of the object, (b) you can make the object, (c) you can see the shape of the object.

10. Dimensions up to and including 72 inches are shown (a) in inches, (b) in feet and inches, (c) in feet and parts of a foot.

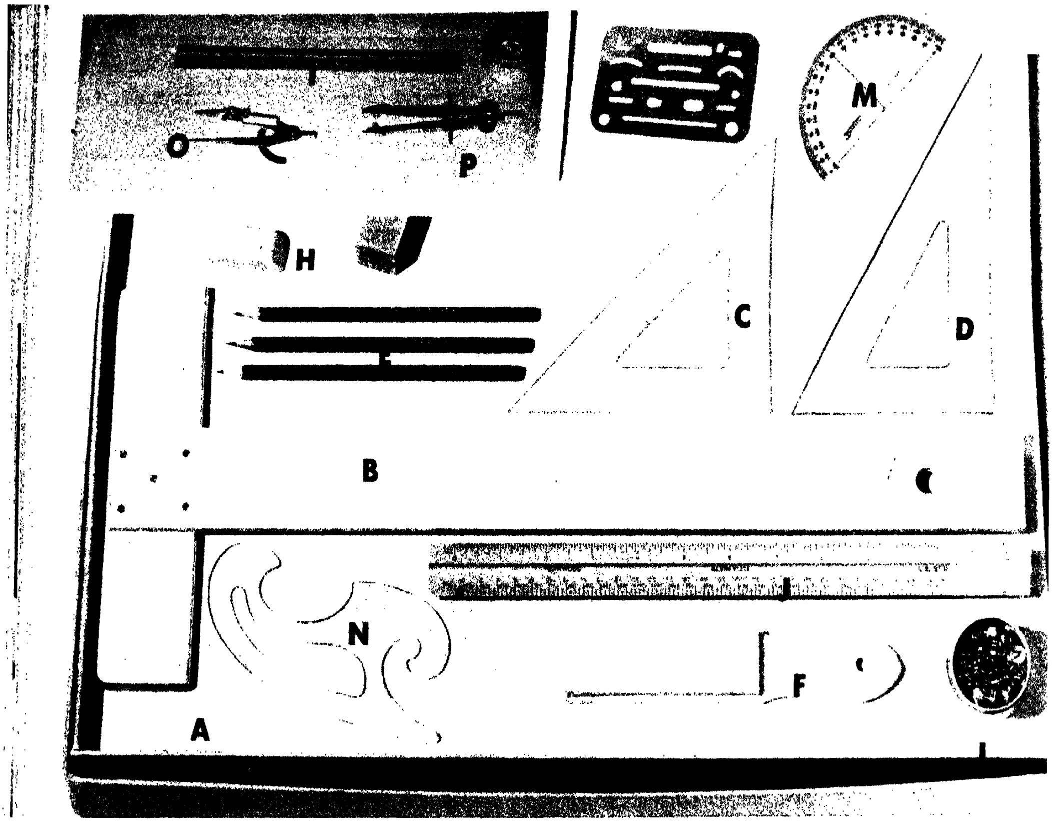
11. The size of a hole is shown as the (a) diameter, (b) radius, (c) cord.

12. In a three-view working drawing the dimensions should be (a) inside the views, (b) between the views, (c) anywhere on the drawing.

13. A drawing that gives complete information about one part is called (a) detail drawing, (b) isometric drawing, (c) assembly drawing.

14. A drawing in which one corner appears closer to the person is called (a) perspective, (b) isometric, (c) cabinet.

15. The drawing that is most like a photograph is the (a) isometric, (b) perspective, (c) cabinet.



I-A-D

SELF-CHECK YOUR DRAWING TOOLS AND EQUIPMENT

A. Drawing Board. To hold the drawing paper. The edges must be straight and smooth.

B. T-Square. To draw horizontal lines. It is held against the right or left edge of the drawing board.

C. 45-degree Triangle. To draw vertical lines and inclined, or slanted, lines at 45 degrees to the horizontal.

D. 30-60 Degree Triangle. To draw vertical lines and inclined, or slanted, lines at 30 and 60 degrees to the horizontal. Used with the 45-degree triangle to draw lines at 15 and 75 degrees to the horizontal.

E Pencils. To "block in" and draw the shape of the object. The most common grades are H, 2H and 3H.

F. Pencil Pointer or Sandpaper Pad. To keep the point of the pencil sharp.

G. Eraser Shield. To help in erasing the correct part of a line.

H. Erasers. To remove unwanted lines. A hard red or ruby eraser is used for lines and a soft gum eraser is used to clean up the drawing.

I. Rule. To measure and mark out lines. Used to make full-size drawings or a drawing to scale. The simplest kind of measuring tool.

J. Scale. To measure and mark out the length of lines. To make a full-size drawing or a drawing to scale.

K. Masking or Drafting Tape. To hold the drawing paper to the board.

L. Thumb Tacks. To hold the drawing paper to the board. Few used today.

M. Protractor. To lay out any angle from 0 to 360 degrees.

N. French, or Irregular, Curve. To draw irregular curves.

O. Pencil Compass. Simplest kind of tool for drawing circles and arcs.

P. Large Bow or Center Wheel Compass.

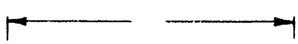
RULES FOR LETTERING

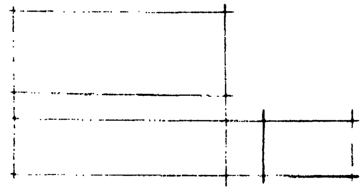
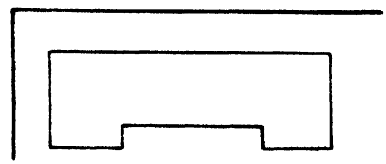
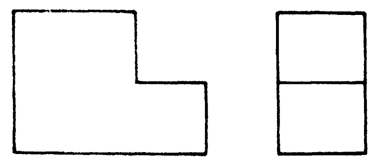
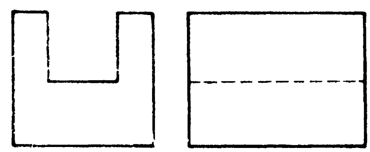
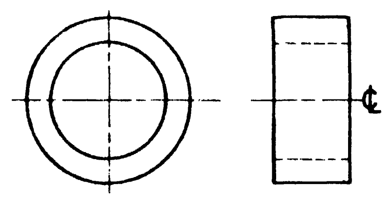
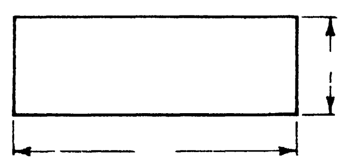
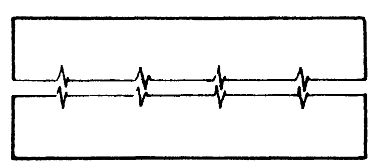
1. Always use guide lines.
2. Use 1/8″ as standard height for most lettering.
3. Use vertical or inclined Gothic letters. Generally only capital letters are used.
4. Vary the distance between the letters so that they look equally spaced.
5. The space between letters should be about one-fourth the width of the average size letter.

Self-Check the Decimal Equivalents

1/64	.015625	.515625	33/64
1/32	.03125	.53125	17/32
3/64	.046875	.546875	35/64
1/16	.0625	.5625	9/16
5/64	.078125	.578125	37/64
3/32	.09375	.59375	19/32
7/64	.109375	.609375	39/64
1/8	.125	.625	5/8
9/64	.140625	.640625	41/64
5/32	.15625	.65625	21/32
11/64	.171875	.671875	43/64
3/16	.1875	.6875	11/16
13/64	.203125	.703125	45/64
7/32	.21875	.71875	23/32
15/64	.234375	.734375	47/64
1/4	.25	.75	3/4
17/64	.265625	.765625	49/64
9/32	.28125	.78125	25/32
19/64	.296875	.796875	51/64
5/16	.3125	.8125	13/16
21/64	.328125	.828125	53/64
11/32	.34375	.84375	27/32
23/64	.359375	.859375	55/64
3/8	.375	.875	7/8
25/64	.390625	.890625	57/64
13/32	.40625	.90625	29/32
27/64	.421875	.921875	59/64
7/16	.4375	.9375	15/16
29/64	.453125	.953125	61/64
15/32	.46875	.96875	31/32
31/64	.484375	.984375	63/64
1/2	.5	1.	1

SELF-CHECK THE KINDS OF LINES

Sample	Name	Pencil
	Construction	3H to 5H
	Border	H or HB
	Visible or Object	H or 2H
	Hidden or Invisible	H or 2H
	Center Line	H or 2H
	Dimension and Extension	2H or 3H
	Long Break	H or 2H
	Short Break	H or 2H

Use	Example
Very light line used to "block in" an object. These lines are made so light that little or no erasing is needed. Serve as base for darkening in the permanent lines.	
Heavy, solid line used to frame in the drawing.	
A heavy line used to outline the exterior shape of a part. Shows outstanding features.	
A medium line used to show edges and contours not visible to the eye.	
A light line used as axis of symmetry. Used for center of circle and arcs. Sometimes the symbol ℄ is shown.	
Light, thin lines used to show the sizes of the object. Extension lines start about 1/16" from visible or object line. The dimension line is broken near the center for the dimension.	
Light, ruled line with freehand zigzags. To break an object when it is too big for paper.	
Wavy line drawn freehand. For same purpose as long break.	

Other important lines are shown in later units when they are first used.

6. The space between words should be about equal to the width of the average size letter.
7. The space between sentences should be about equal to twice the height of the letters.
8. The space between the lines of a sentence should be about equal to the height of the letters.

INFORMATION ABOUT YOURSELF

(I-B-6)

1. Name
   Last First Middle
2. Street Address
3. Home Phone Number
4. Age
5. Grade
6. Home Room
7. Previous Shop or Drawing Courses
8. Hobbies or Outside Interests
9. Name and Kind of Projects You Have Built
10. Name and Kind of Projects Other Members of the Family Have Built

Letter these slogans, or posters:

(I-B-10)

1. Plan your work and then work your plan.
2. Safety is everybody's business.
3. Always be careful. Come back alive.
4. Sharp tools will cut.
5. A place for everything and everything in its place.
6. Keep the shop clean.
7. Report all accidents promptly.

I pledge to obey these 12 rules for SAFE BICYCLING

(I-B-9)

1. *Observe all traffic regulations*—red and green lights, one-way streets, stop signs.
2. *Keep to the right* and ride in a straight line. Always ride in single file.
3. *Have white light on front* and danger signal on rear for night riding.
4. *Have satisfactory signaling device* to warn of approach.
5. *Give pedestrians the right of way.* Avoid sidewalks—otherwise use extra care.
6. *Look out for cars pulling out into traffic.* Keep sharp look-out for sudden opening of auto doors.
7. *Never hitch on other vehicles,* "stunt" or race in traffic.
8. *Never carry other riders*—carry no packages that obstruct vision or prevent proper control of cycle.
9. *Be sure your brakes are operating efficiently* and keep your bicycle in perfect running condition.
10. *Slow down at all street intersections* and look to right and left before crossing.
11. *Always use proper hand signals* for turning and stopping.
12. *Don't weave in and out of traffic* or swerve from side to side.

Section I—APPLYING WHAT YOU HAVE LEARNED:

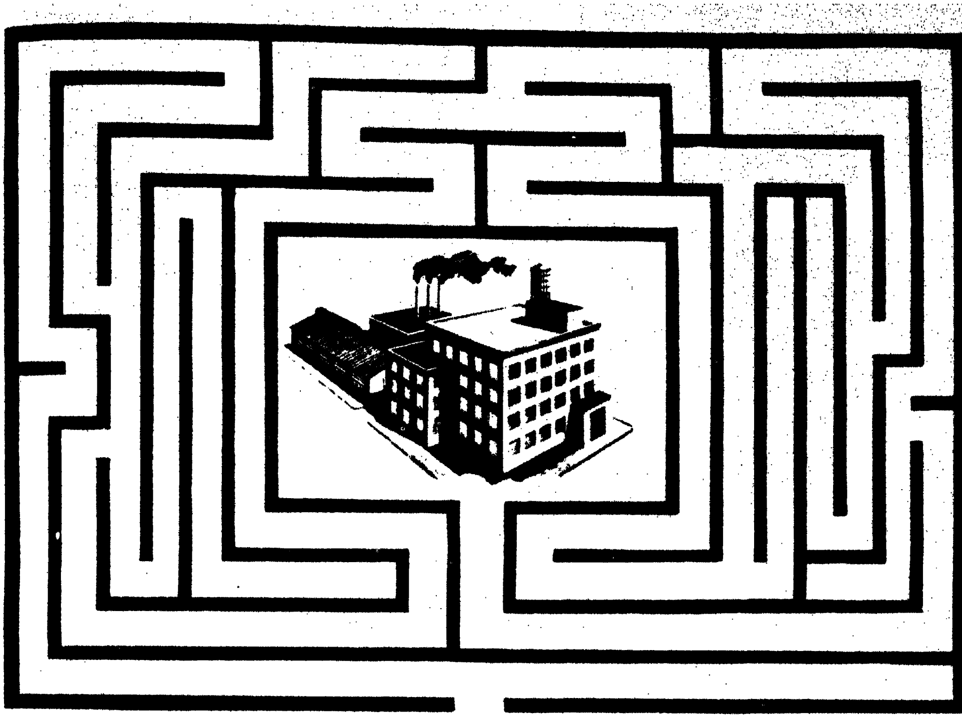
ACTIVITIES, THINGS TO DO, PROBLEMS, EXPERIENCES

A. Complete each of the following activities on a sheet of 8 ½" x 11" paper. *Do not draw a border and title block.* Letter your name at the bottom of each sheet.

1. Place a thin piece of paper over Fig. I-A-1. Trace with your pencil from the outside opening to the building without crossing a line. Can you do it quickly? This will test your ability "to see what's in a drawing".

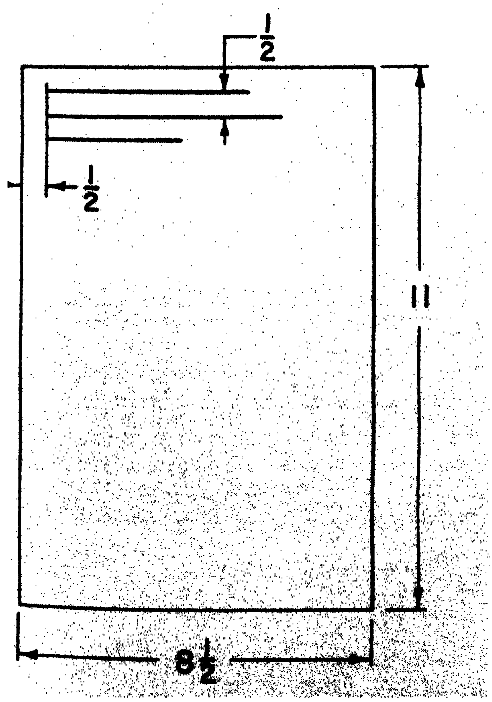
2. Place the paper on the drawing board as shown in Fig. I-A-2, and draw the following lines: (a) 2", (b) 2½", (c) 2¾", (d) 3¼", (e) 4⅛", (f) 5 3/16", (g) 4⅞", (h) 6 3/16", (i) 7/16", (j) 7⅜", (k) 5 5/16", (l) 3¼", (m) 7 5/16", (n) 4¼", (o) 3 9/16", (p) 2 8/16".

3. In Fig. I-A-3 you see the finish of a soapbox derby race. Can you draw the

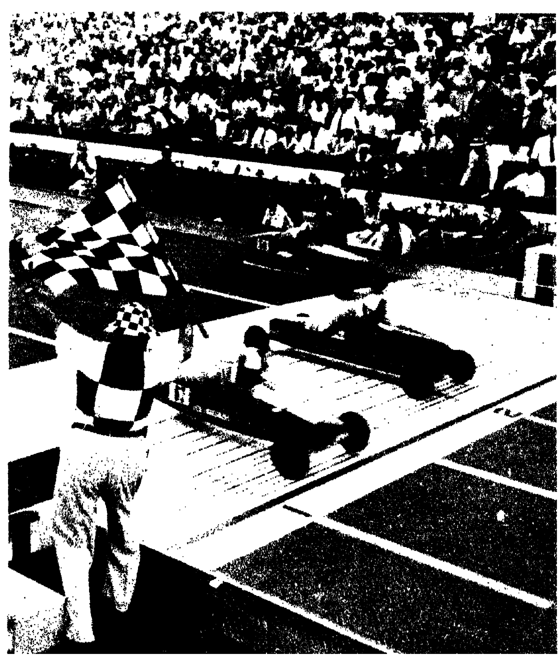


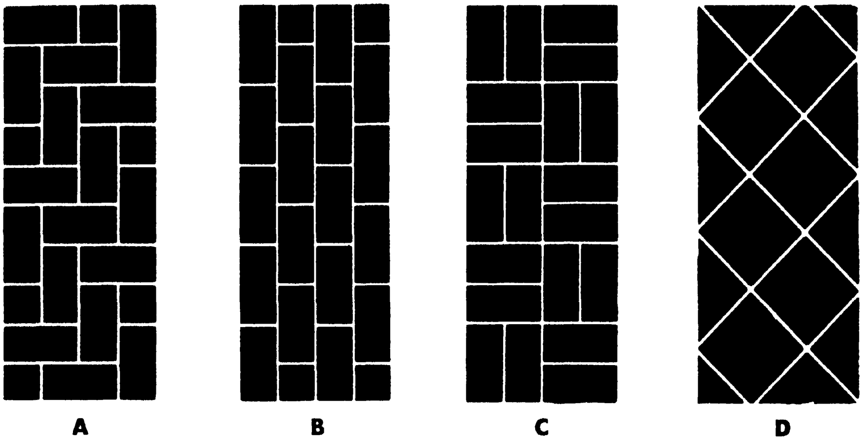
I-A-1

I-A-2



I-A-3





SUGGESTED FLOOR PATTERNS

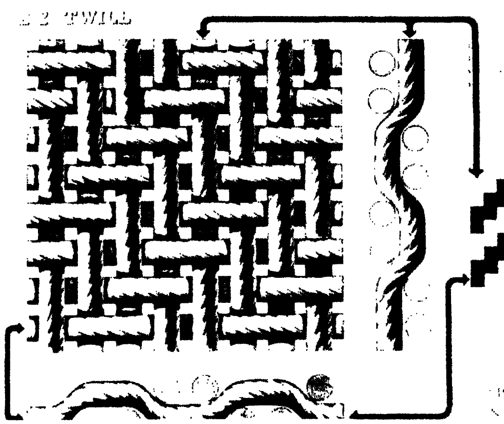
I-A-4

finish flag? It will give you practice in accurate measuring and in drawing vertical and horizontal lines. There are 36 squares —6 on a side—in the flag. Make each square 1″. Darken every other square as shown.

4. Here are some suggested floor patterns that might be made of special wood flooring. Fig. I-A-4. Place your paper with the long side in a horizontal position. Draw each pattern as shown. In A, B, and, C the large tiles are 1/4″ x 1/2″ and the small ones are 1/4″ x 1/4″. In D each tile is 1/2″ x 1/2″.

5. Suits, dresses and other clothing for men, women, boys and girls are made of 2/2 twill. A drawing must be made to show the design and construction of this cloth. Fig. I-A-5. Make a design for this cloth of 1″ squares.

6. Divide a sheet of paper into four parts and draw the following: (a) 2″ square, (b) 2 1/8″ x 4 1/4″ rectangle, (c) right triangle 2 1/2″ high with a base of 3 1/8″, (d) circle 3 1/2″ in diameter.

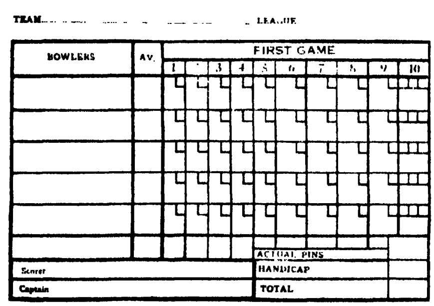


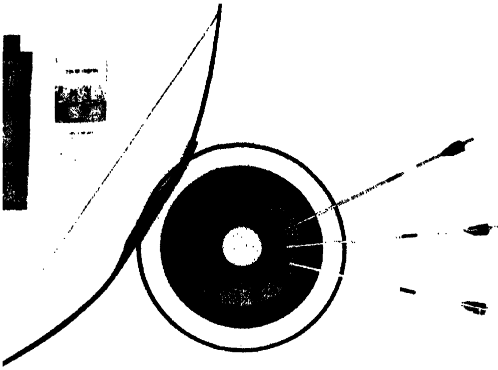
I-A-5

7. Here are two record forms used for bowling and softball. Fig. I-A-7. Divide

I-A-7 (1) I-A-7 (2)

SCORE BOARD								
TEAMS	1	2	3	4	5	6	7	TOTAL

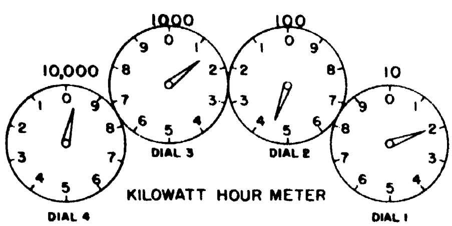




I-A-8

your sheet into two equal parts and draw these forms.

8. For archery you need a target as shown in Fig. I-A-8. Make the smallest circle 1¼" in diameter and letter it with the number 9. Make each larger circle 1¼" greater in diameter and letter with numbers 7, 5, 3, 1. To make a larger regulation target, draw each circle four times as large.



I-A-10

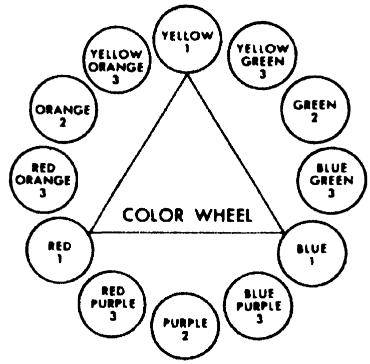
9. The coins you use are each a certain diameter. Draw each full size: (a) dime $\frac{11}{16}$", (b) penny ¾", (c) nickel $\frac{13}{16}$", (d) quarter $\frac{15}{16}$", (e) fifty cents $1\frac{3}{16}$", (f) silver dollar 1½".

10. Fig. I-A-10 shows the dials of an electrical meter used to measure the electricity your family uses. Read the meter in your own home. Then make a drawing of the meter face with the correct reading. Make each dial 1½" in diameter.

11. Here is a color wheel used in painting and decorating. Fig. I-A-11. Draw it to some suitable size.

12. Fig. I-A-12 shows the telepnone dial. Measure the dial in your home and draw it full size.

13. Good food makes for good health. Each week you should eat some of the foods shown in the circle chart. Draw this



I-A-11

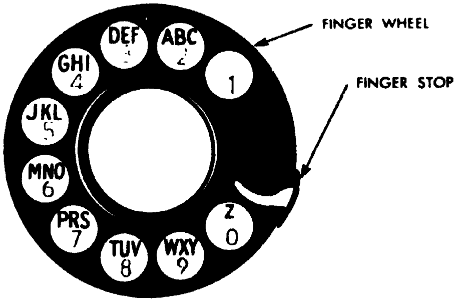
chart making the smallest circle 1", the next circle 1¾" and the largest circle 6". Fig. I-A-13.

14. Make a form as shown in Fig. I-A-14a and keep a record of what you eat for one week. Did you have a balanced diet? Did you eat enough of each food? Check with the chart in Fig. I-A-14b.

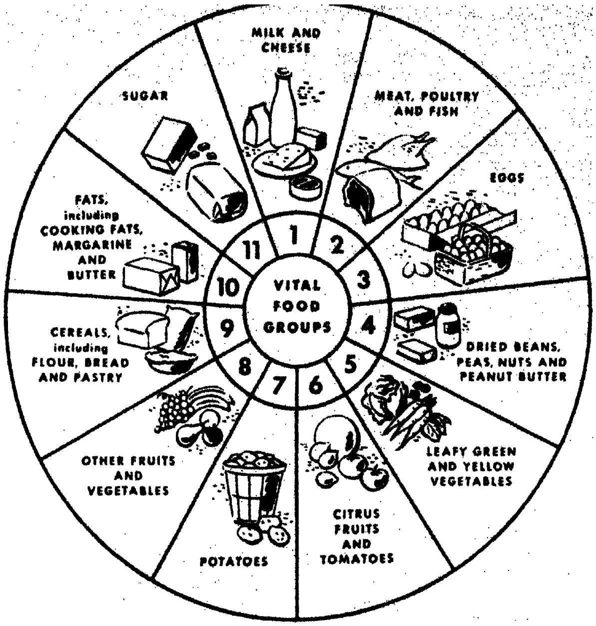
15. In Fig. I-A-15 you see the flags of some countries you should know. Select four of these and make a drawing of each flag 2" x 3" in size. If you want to, you may color them as shown in the code. Can you find the flag of one of the following countries and draw it: Iceland, Denmark, Norway or Belgium? They are all simple designs.

16. Do you ever wonder what time it is in other parts of the world? You can find out quickly by making a world time wheel. Draw the center part on one piece of paper

I-A-12



FRONT OF DIAL



I-A-13

I-A-14A

WHAT I ATE THIS WEEK

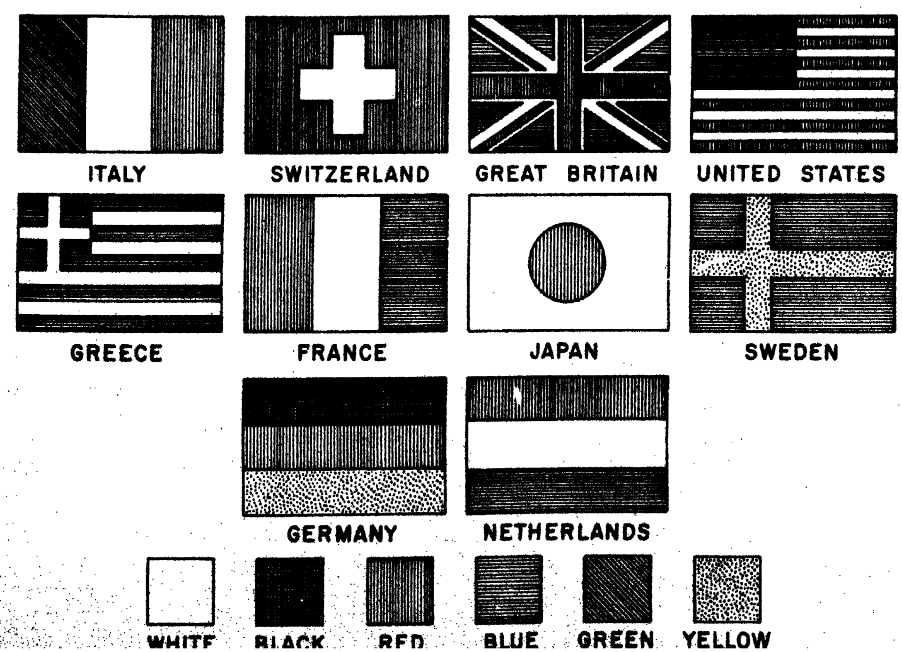
	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY	TOTAL
1-MILK & CHEESE	B L D	B L D	B L D	B L D	B L D	B L D	B L D	B L D
2-MEAT POULTRY & FISH	B L D	B L D	B L D	B L D	B L D	B L	B	
3-EGGS	B L D	B L D	B L	B				
4-DRIED BEANS, PEAS, NUTS, & PEANUT BUTTER	B L D							
5-LEAFY GREEN & YELLOW VEG.	B L D							
6-CITRUS FRUITS & TOMATOES	B L D							
7-POTATOES								
8-OTHER FRUITS & VEGETABLES								
9-CEREALS FLOUR, BREAD & PASTRY								
10-FATS, MARGARINE BUTTER								
11-SUGAR, CANDY, ETC.								

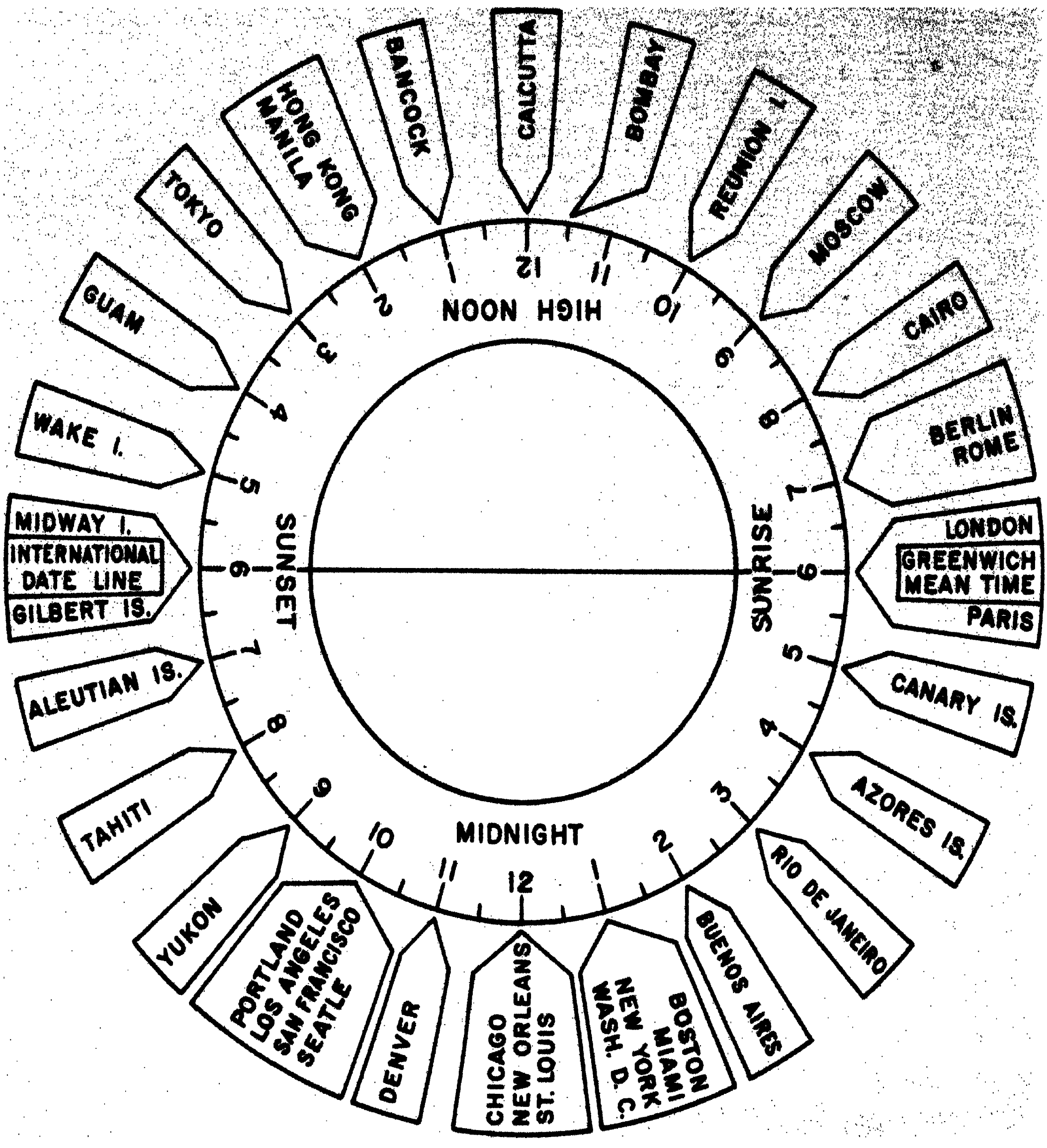
AMOUNTS OF FOOD REQUIRED WEEKLY

TYPE OF PERSON	MILK	MEAT, FISH, POULTRY	EGGS	DRIED BEANS, PEAS, NUTS	TOMATOES, CITRUS FRUIT	LEAFY GREEN & YELLOW VEGETABLES	POTATOES & SWEET POTATOES	OTHER FRUITS & VEGETABLES	FLOUR, CEREALS, BREADS	FATS	SUGAR, SYRUP, MOLASSE JAMS, CAN ETC.
CHILDREN 9-12 months 1-3 years	6 quarts 7 quarts	Strained daily 6-8 oz.	5 6	None or limited quantity	1½-2 lbs. 2-2¼ lbs.	1¼ lbs. 1½ lbs.	1 lb. 1¼ lbs.	1 lb. 2¼ lbs.	12 oz. 1 lb.	1 oz. 2 oz.	1 oz. 2 oz.
CHILDREN 4-6 years 7-9 years 10-12 years	7 quarts 7 quarts 7 quarts	12-14 oz. 1 lb. 12-14 oz. 2½-2¾ lbs.	7 7 7	1 oz.	2½-2¾ lbs. 3-3¼ lbs. 3-3¼ lbs.	2½ lbs. 3½ lbs. 3½ lbs.	1¾ lbs. 2 lbs. 2½ lbs.	4½ lbs. 6 lbs. 6¼ lbs.	1 lb. 6 oz. 1¾ lbs. 2½ lbs.	5 oz. 8 oz. 13 oz.	5 oz. 8 oz. 13 oz.
GIRLS 13-15 years	7 quarts	3-3½ lbs.	7	2 oz.	4-4¼ lbs.	3½ lbs.	3 lbs.	6¼ lbs.	3 lbs.	15 oz.	15 oz.
GIRLS 16-20 years	7 quarts	3½-3¾ lbs.	7	1 oz.	4-4¼ lbs.	3½ lbs.	3 lbs.	7 lbs.	1½ lbs.	12 oz.	12 oz.
BOYS 13-15 years	7 quarts	3¾-4 lbs.	7	4 oz.	4½-4¾ lbs.	4 lbs.	3½ lbs.	8 lbs.	3½ lbs.	1 lb.	1 lb. 2 o
BOYS 16-20 years	7 quarts	4¾ lbs.	7	4 oz.	5 lbs.	4 lbs.	4½ lbs.	9 lbs.	3¾ lbs.	1 lb. 9 oz.	1 lb. 9 o

I-A-14B

I-A-15





I-A-16

and the other part on another piece. Cut out the circle center and fasten it to the second piece with a pin through the center. Turn the wheel to the time of day in your time zone. You can then read directly the time in other parts of the world. Fig. I-A-16.

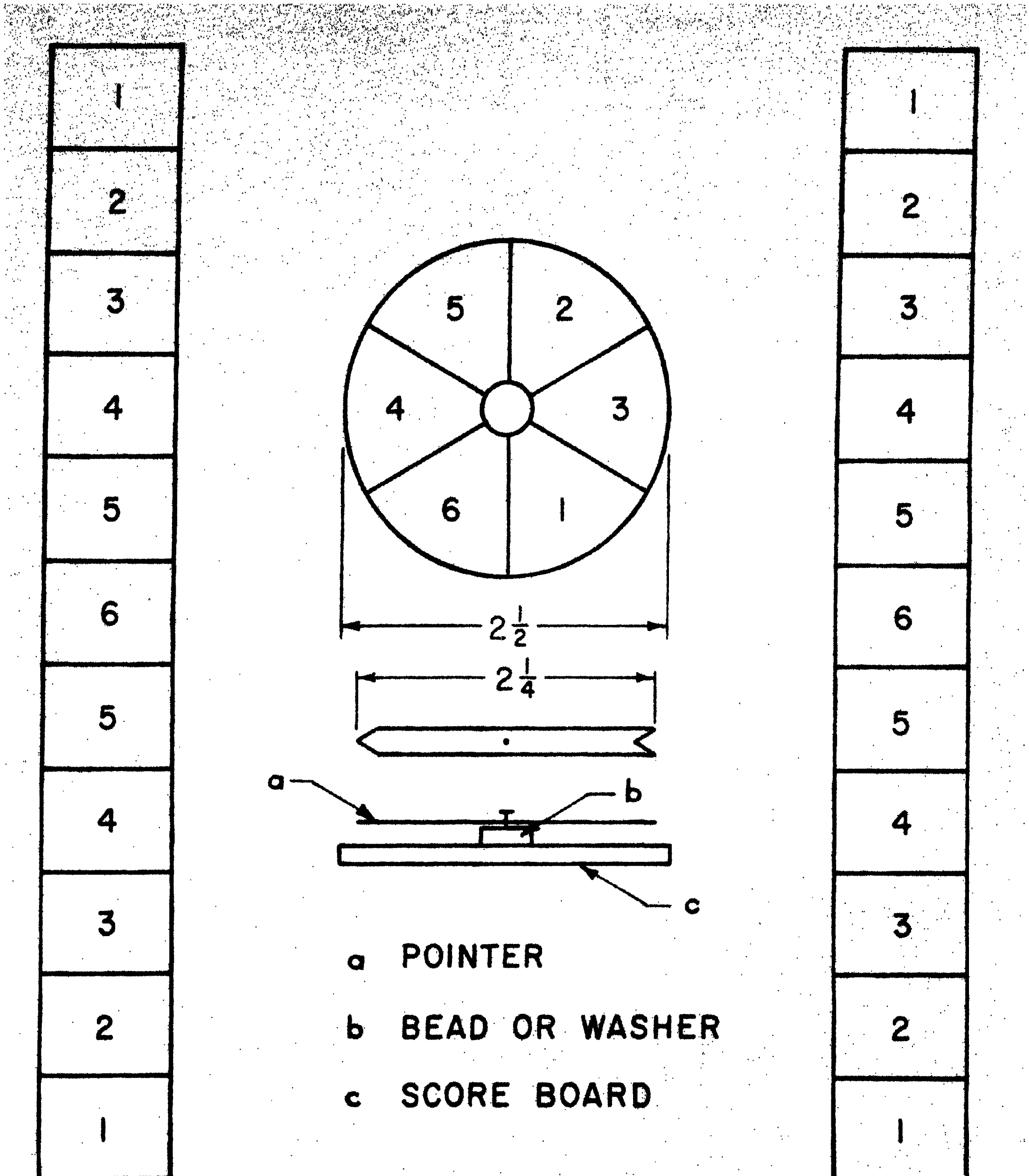
17. Draw the squares and circles shown in Fig. 4-3 to Fig. 4-7. Make each square and circle 2″ in size.

18. Top Score: Here is a game that is easy and fun to play with one other person. Fig. I-A-18. Draw a column on either side of a sheet of paper. Make each rectangle ¾″ x 1″. You also need a spinner. Cut the score board and pointer from heavy paper, thin metal or wood. To play the game:

a. Use markers such as pennies or match sticks.

b. Allow each person to turn on the spinner. Place a marker over the correct square.

c. Continue the game until one player



I-A-18

has his column filled. You may have two or more markers on some squares. For example, if you spun 5 three different times you would have two markers on one five and another marker on the other five.

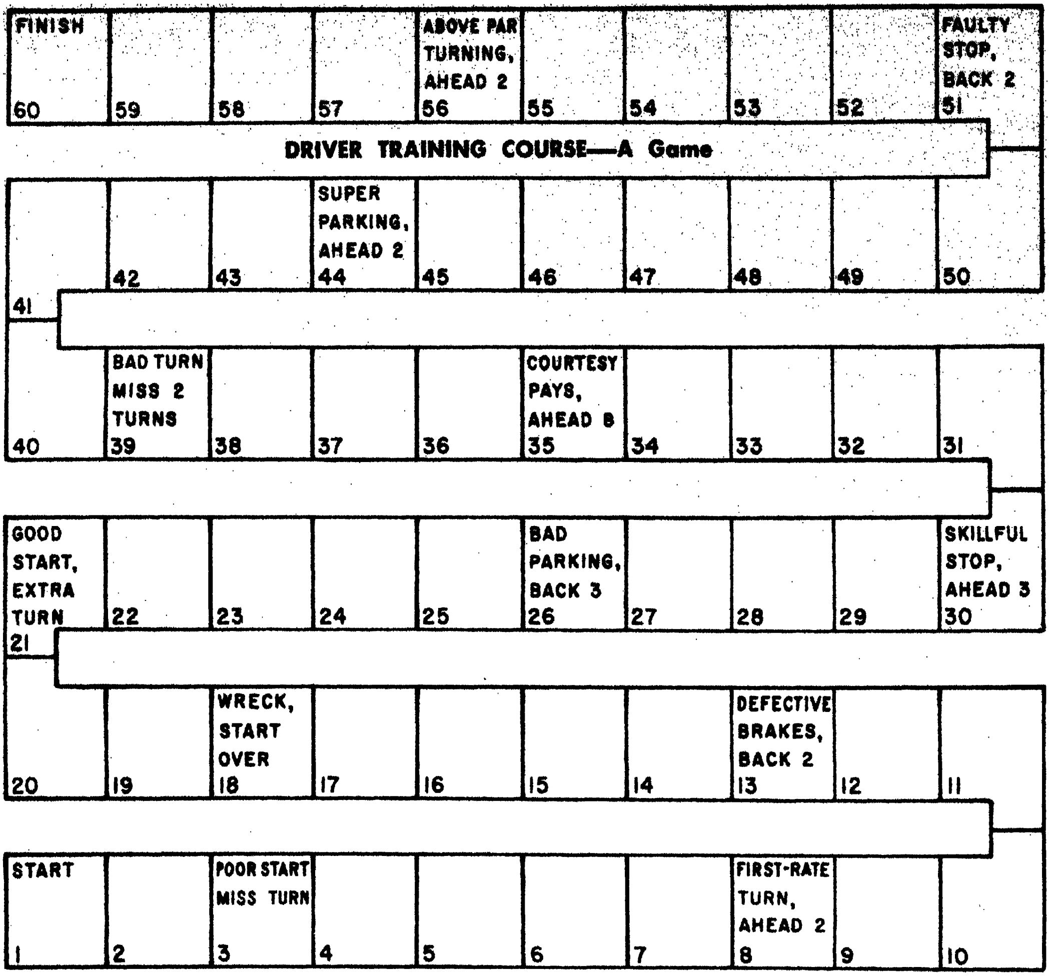
d. Give five points for the first person to go out.

e. The winner is the person with the "top score".

19. Driver Training Course: Draw the course on a piece of 8½" x 11" paper. Fig. I-A-19. Mark each square 1" in size and the space between ½". Make a spinner from a piece of thin metal or heavy cardboard. Cut to shape. To play the game:

a. Select a colored marker for each player. Golf tees or small buttons are good.

b. Each player uses the spinner.



I-A-19

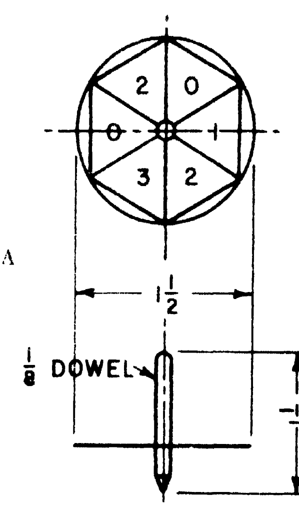
c. Follow the directions on the course.

d. The first one over the course is the winner. Any number can play the game.

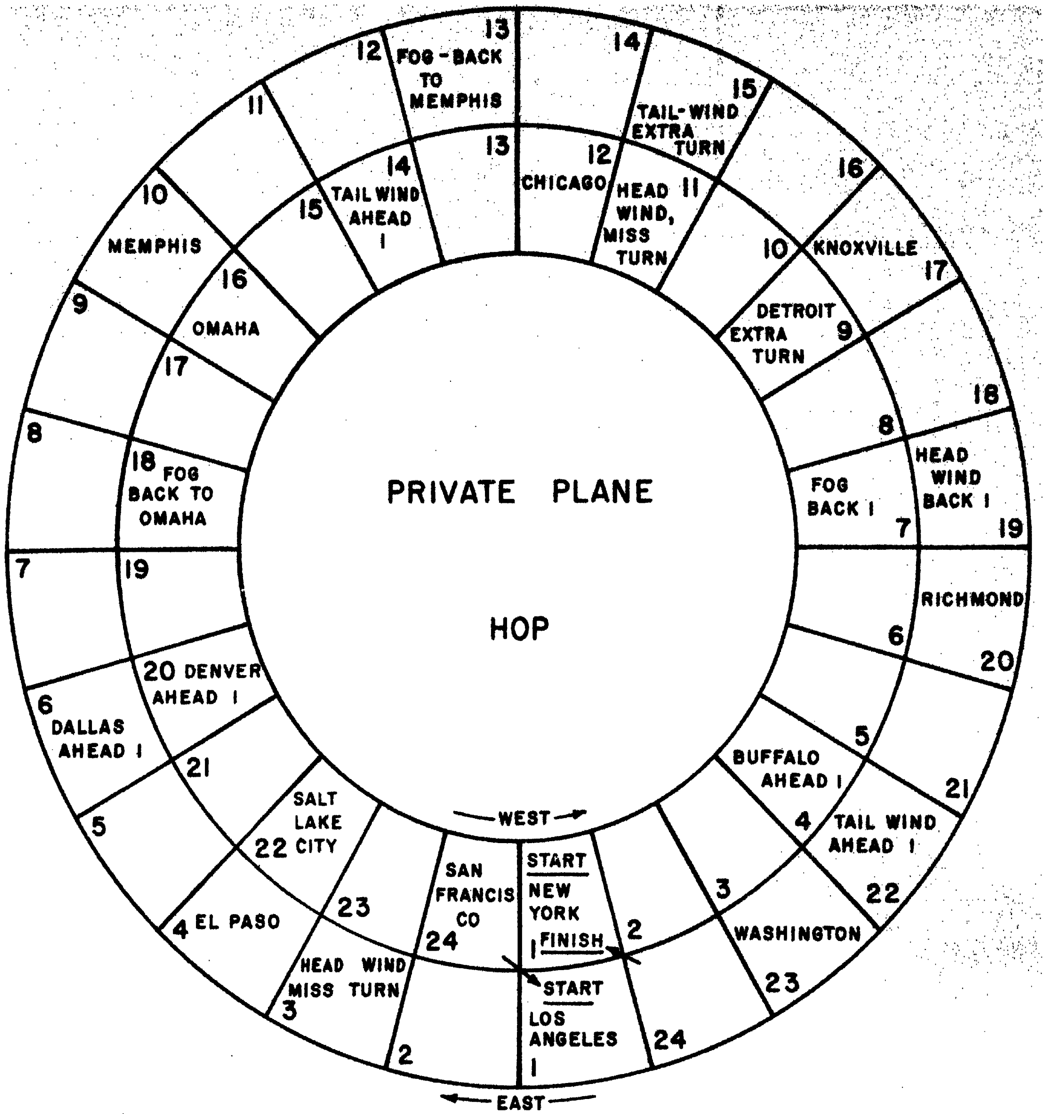
20. Private Plane Hop: Lay out the circular course to any desired size. Fig. I-A-20. The bigger the better; each section is a 15-degree segment of a circle. Make the layout as shown in Fig. 4-8 or step off the segments with a dividers. Cut a small cube of wood and mark the sides as shown. The other sides are marked with duplicate numbers—1, 2, and 3. To play the game:

a. Use colored markers for each player. Any number can play.

b. Start at New York and go counter clockwise on the inner circle. Follow the directions.



I-A-19-A

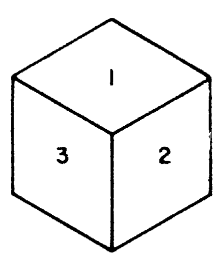


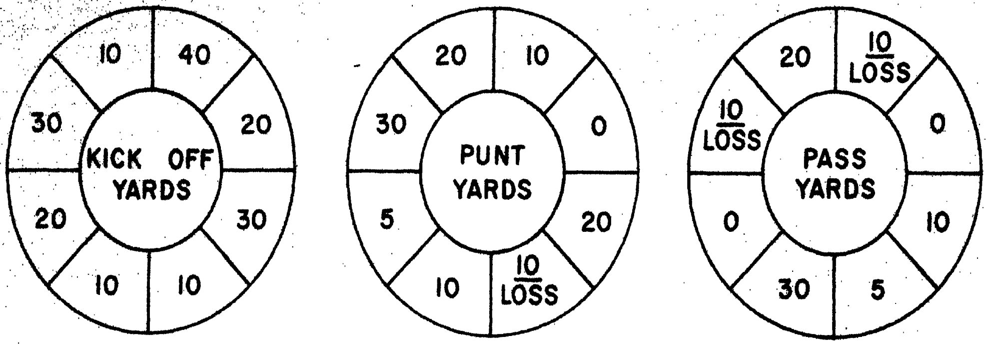
I-A-20-A

c. Come back clockwise on the outer circle. The first plane to reach New York is the winner.

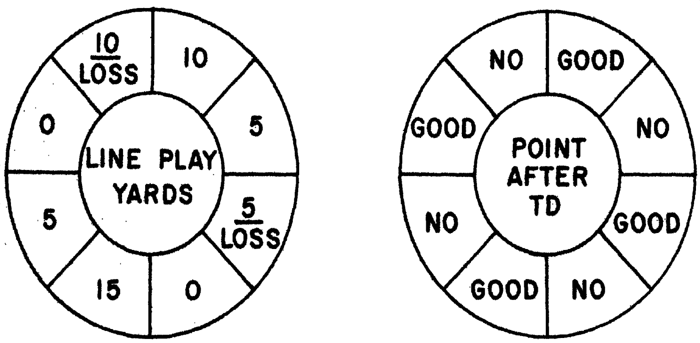
21. Football: Here is a game that can be played just like the real thing. Draw a football field as shown in Fig. 9-7. Divide the 10-yard markers into equal parts so there are 5, 10, 15 yard lines, etc. Make five score bases with a pointer for

I-A-20B

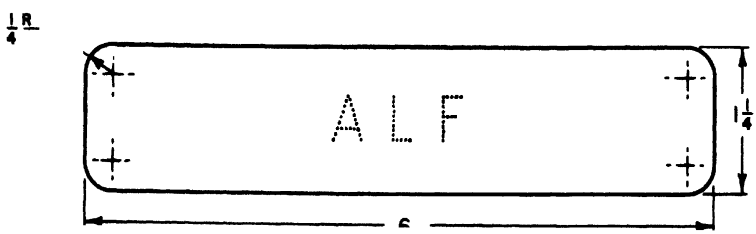


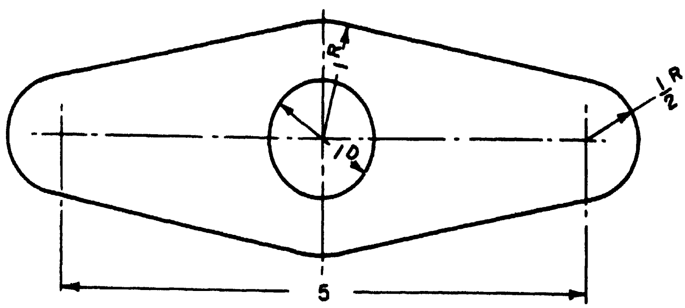


FOOTBALL—A Game

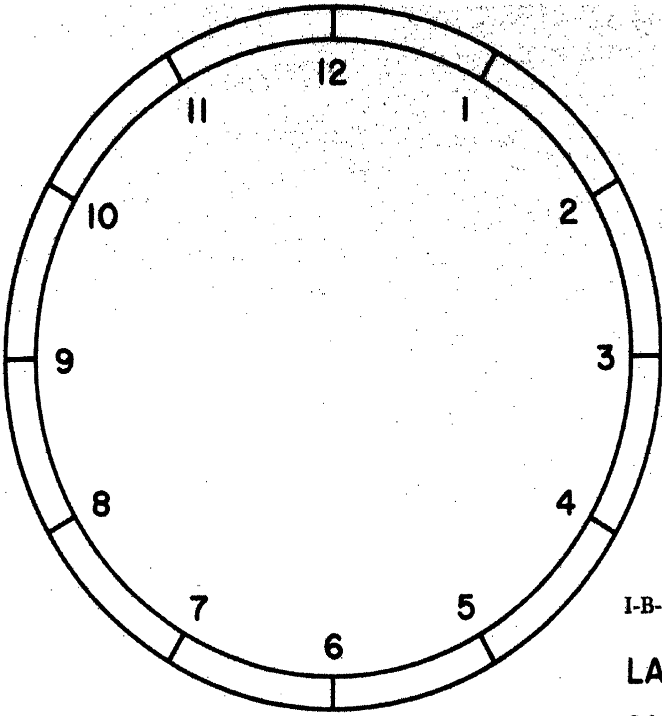


I-A-21





I-B-3



I-B-4

LARGE DIAMETER 5

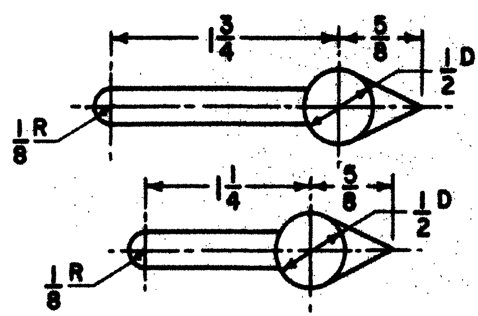
SMALL DIAMETER $4\frac{1}{2}$

each one. Fig. I-A-21. Use a simple marker for the football like a golf tee or colored pin. To play the game:

a. Have the first player or team start on the 40-yard line to kick off.

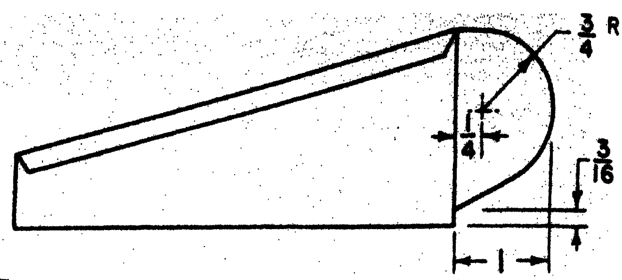
b. Follow regular rules for the rest of the game.

c. Use a time limit or a score to limit the length of the game.

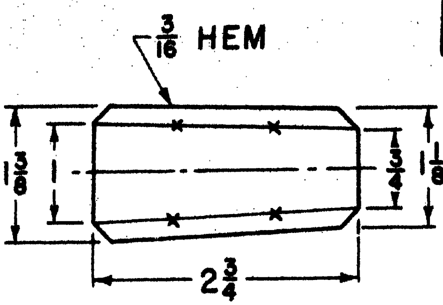


B. In the following activities, first draw a border and title block or record strip, as shown in Fig. 6-6 or Fig. 6-8.

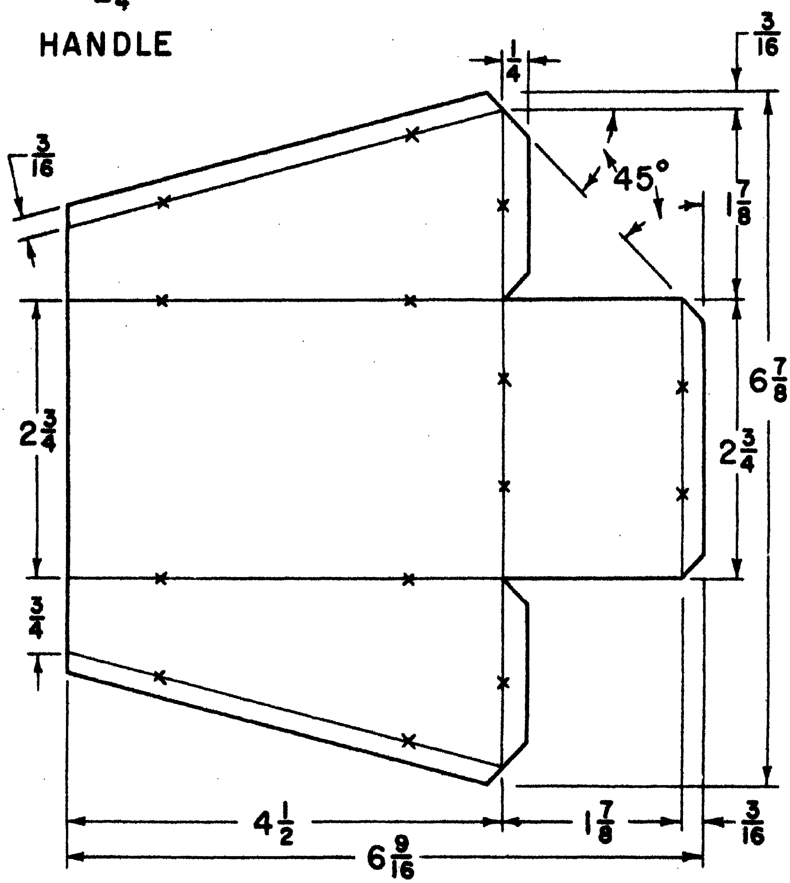
1. Draw the cheese cutting board as shown in Fig. 6-6.
2. Make a full-size drawing of the match box cover, Fig. 6-4.
3. Make full-size drawings of the arm band and bracelet patterns in Fig. I-B-3.
4. Make a full-size drawing of the clock face shown in Fig. I-B-4.
5. Here are patterns for the two parts of a sugar scoop. Fig. I-B-5. Make a full-size drawing of each part. Place both of them on the same sheet of paper.
6. Letter the information in an application form such as this one. Fig. I-B-6. Draw your own application form on a piece of blank paper. See page 116.
7. Letter 100 words telling about yourself. Include your name, address, phone number, age, grade, home room, previous shop courses, hobbies, etc.
8. Letter these rules for lettering. Fig. I-B-8. See page 113 and 116.
9. Letter these 12 rules for safe bicycling. Fig. I-B-9. See page 116.



SIDE VIEW



HANDLE



BODY

School________________________________Grade__________

Name

____

Street City State

Principal____

Teacher____

Teacher's Summer Address______________________________

Student________________________________Age__________

(Print or Type)

____

Street City State

Description of Entry__________________________________

________________________No. of Pieces________________

DO NOT WRITE IN THIS AREA

C. N.________________Cl.________________Gr.________________

I-B-6

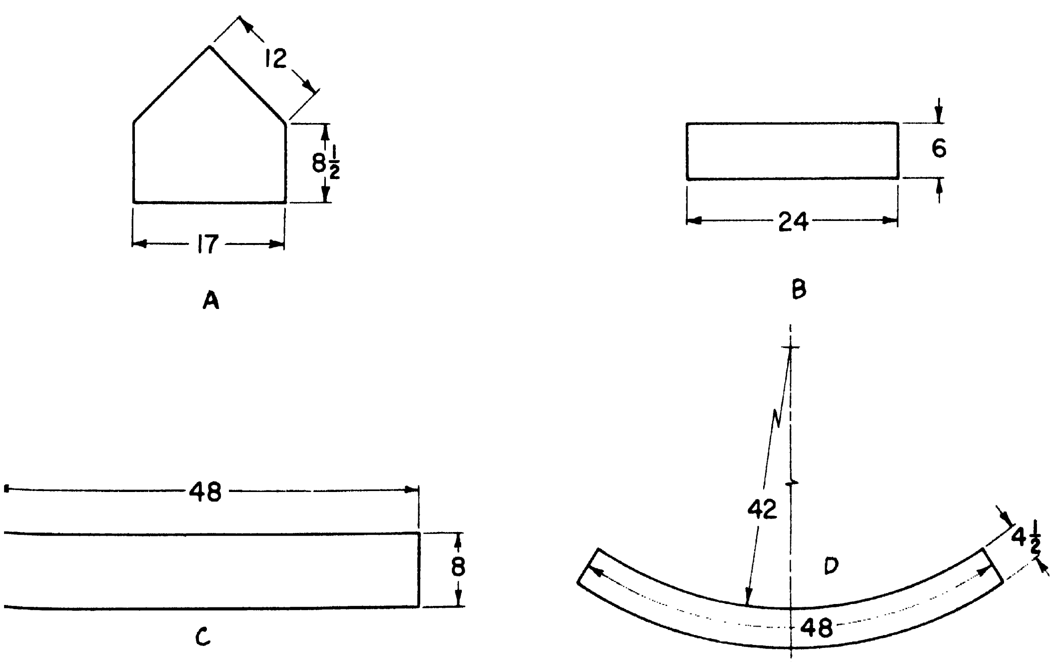
10. Letter these shop slogans or posters. Fig. I-B-10. See page 116.

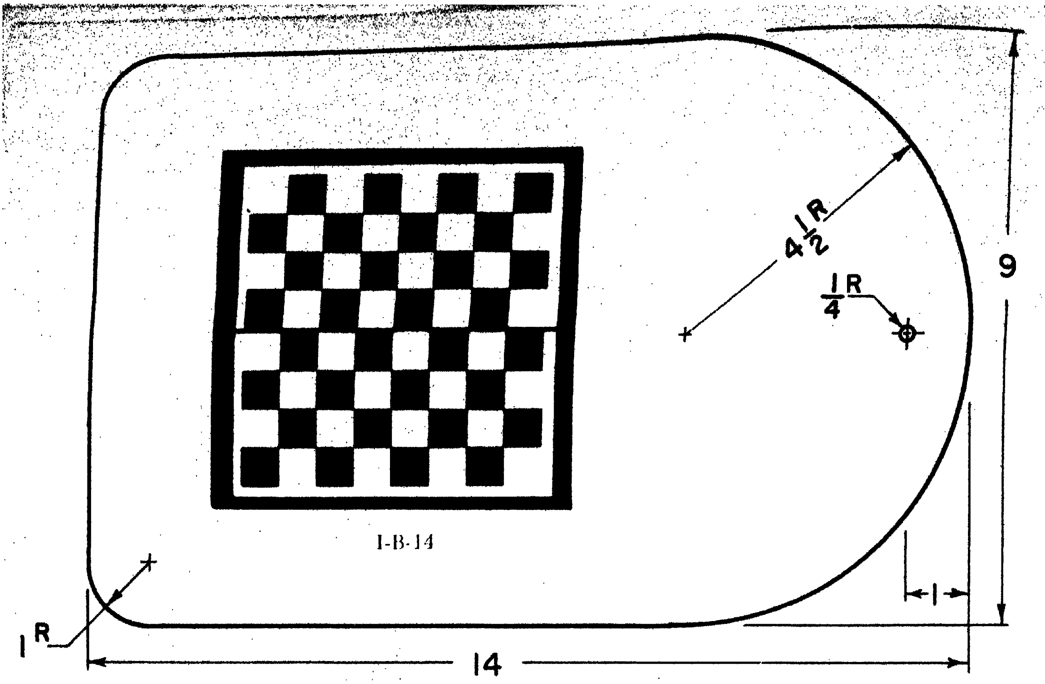
11. Draw the balls shown in Fig. 9-3 to the scale shown. If possible, find the diameter of the following balls and draw to a suitable scale: tennis ball and softball.

12. Make a drawing of the wastepaper basket shown in Fig. 9-5 half size.

13. Divide a sheet into four equal parts and make a scale drawing of the common sports items shown in Fig. I-B-13. (a) Home plate. (b) Pitcher's plate. (c)

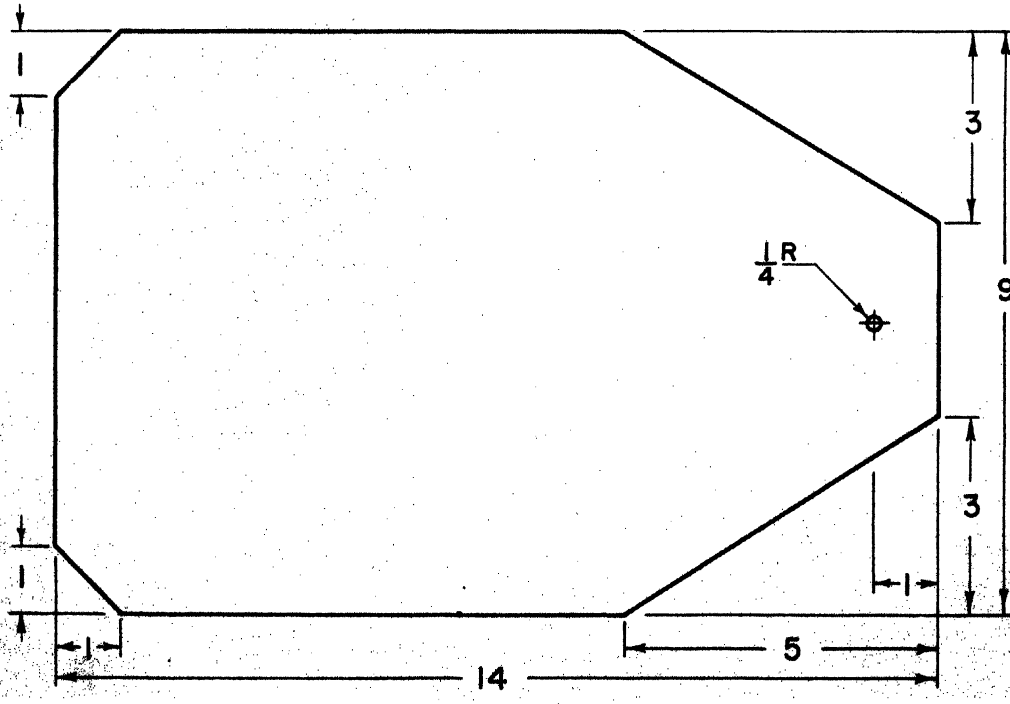
I-B-13



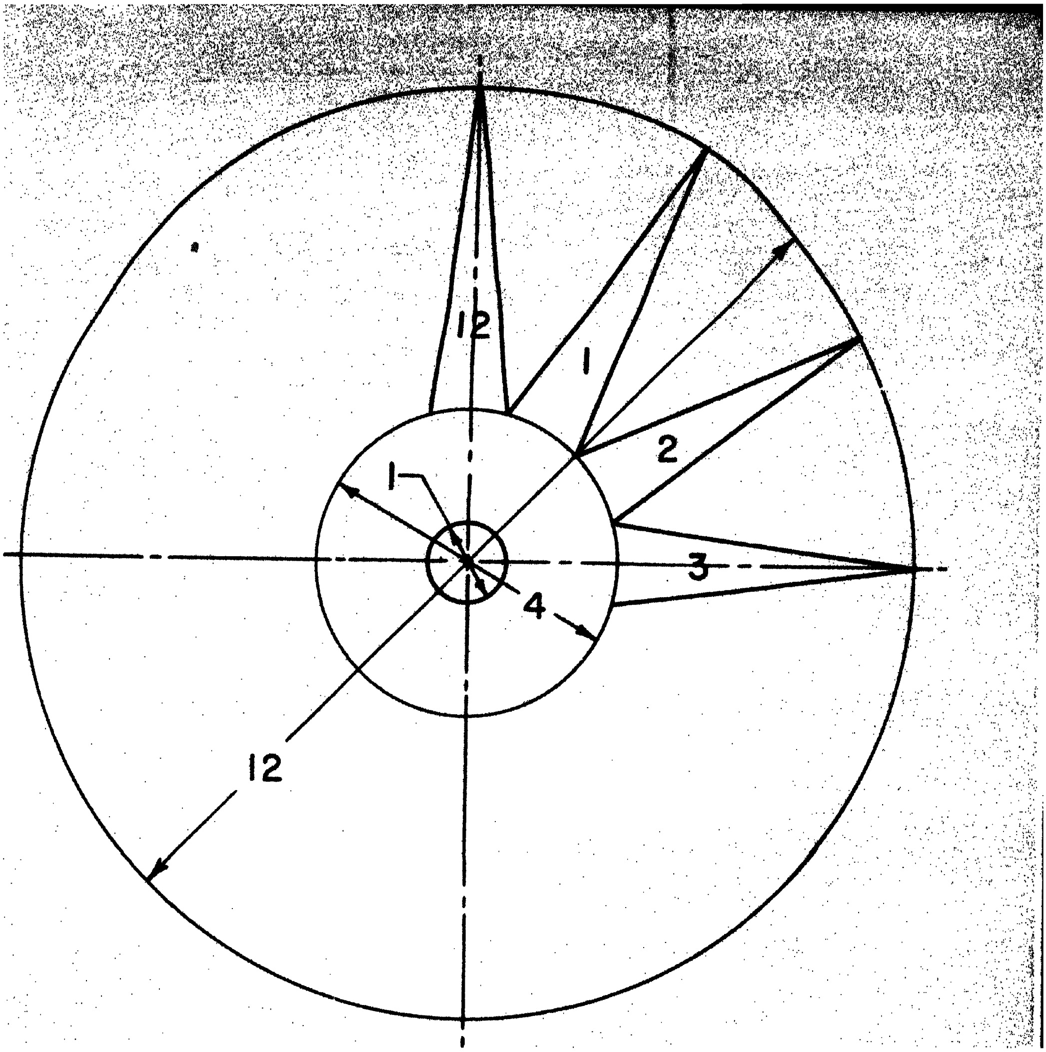


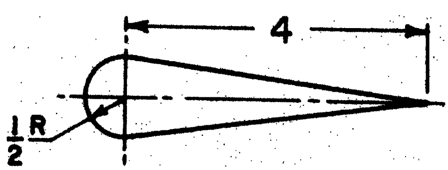
I-B-14

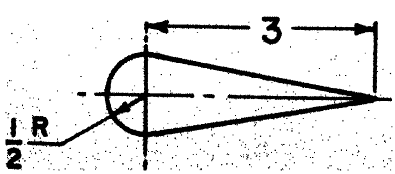
I-B-15-A



I-B-15-B





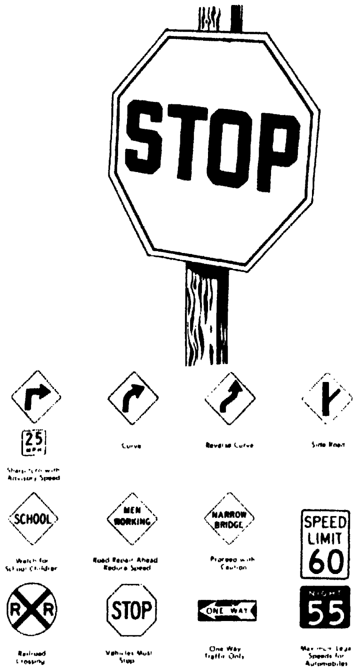


I-B-16

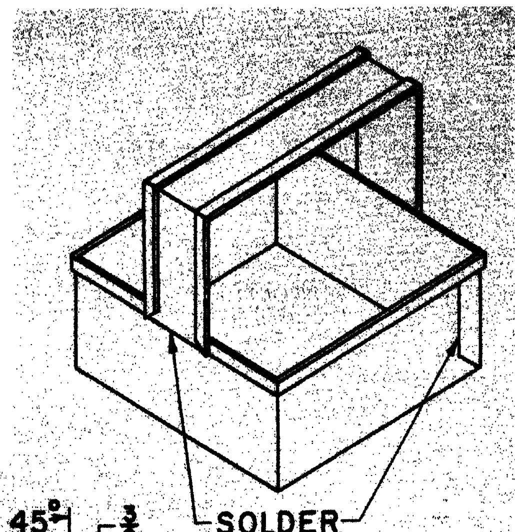
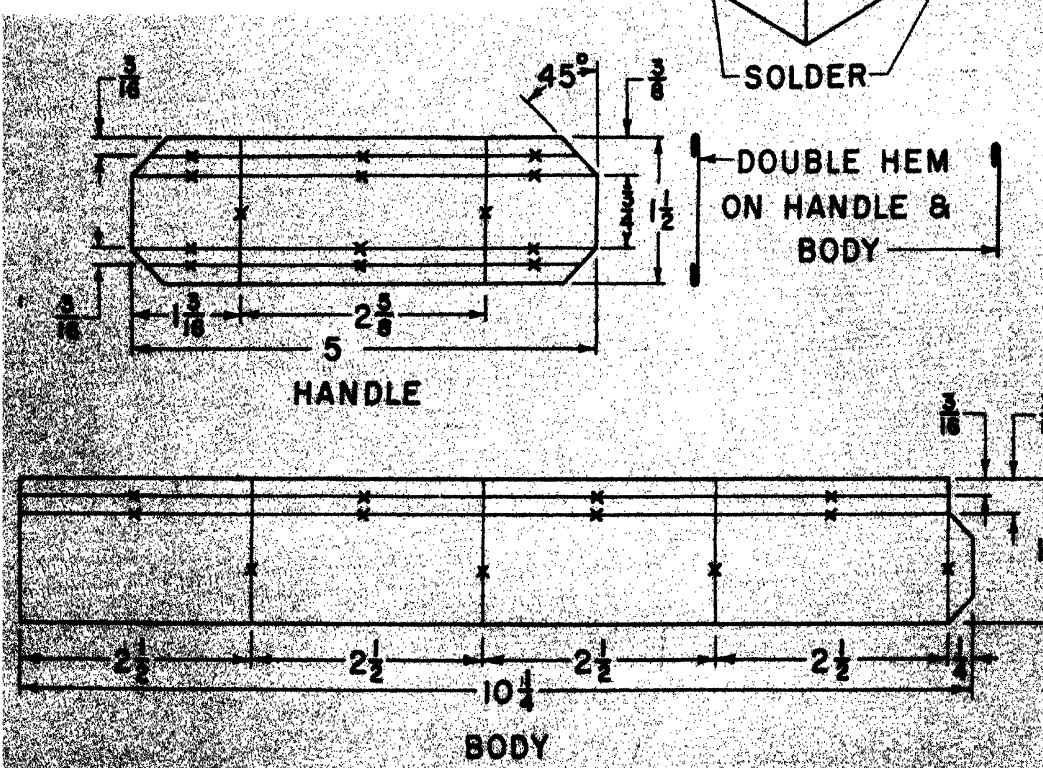
Broad jump take off board. (d) Shot put stop board.

14. Draw the checkerboard shown in Fig. I-B-14 to some suitable scale. Each square is 2" in size and the frame is ½" wide.

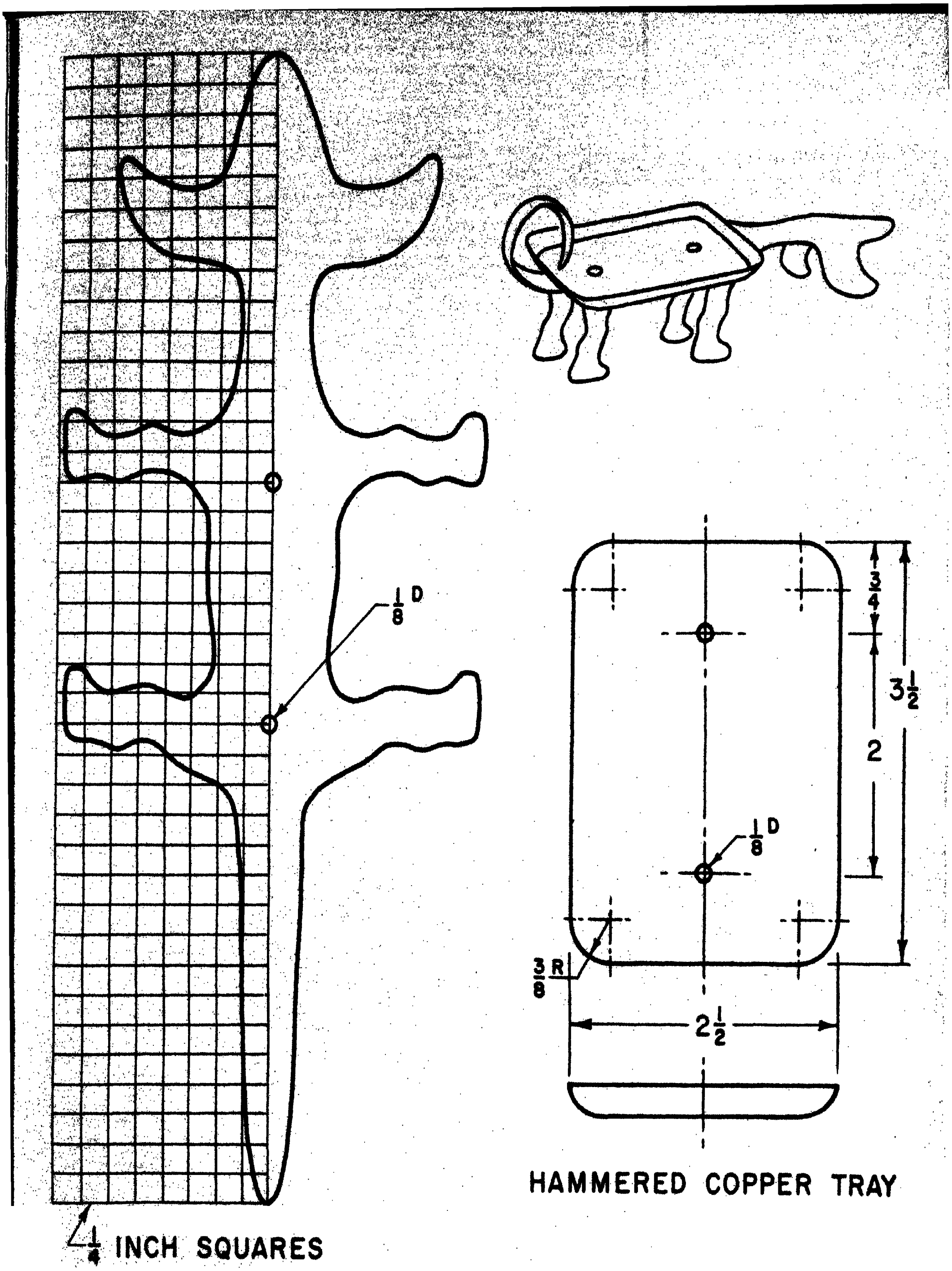
15. Make a scale drawing of one of the cutting boards shown in Fig. I-B-15.



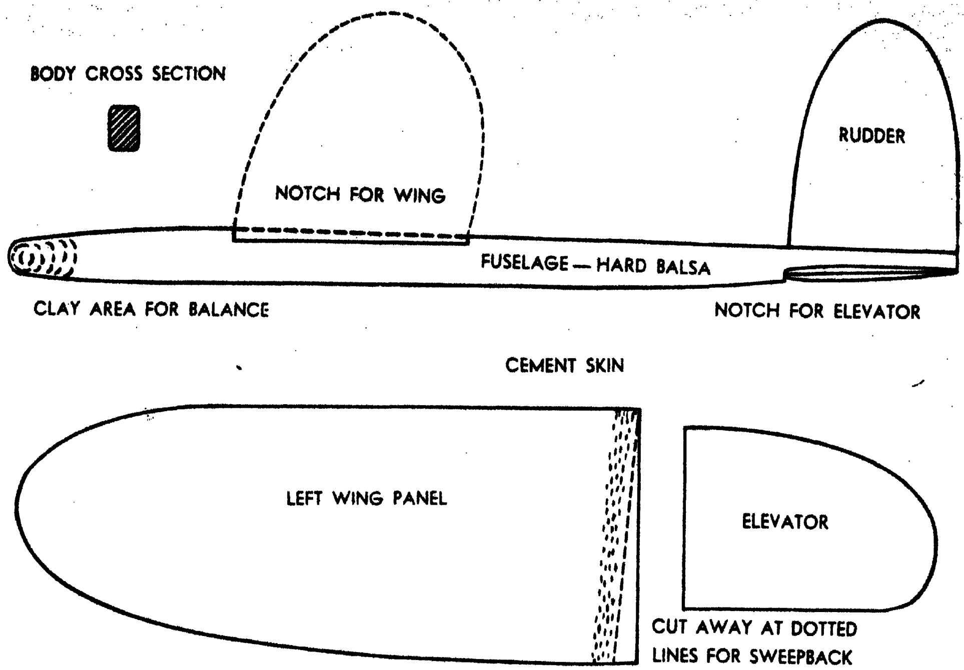
I-B-17

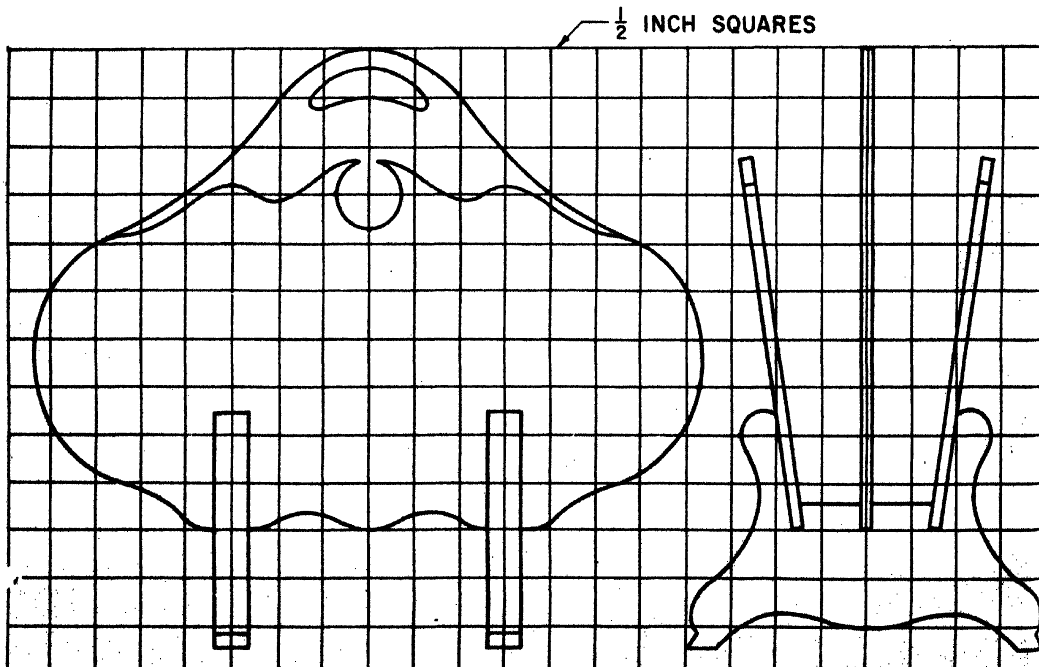
I-C-1

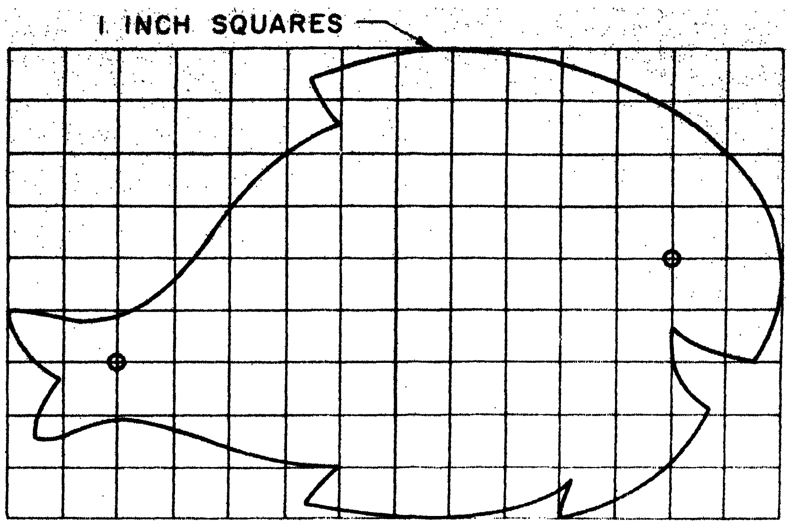


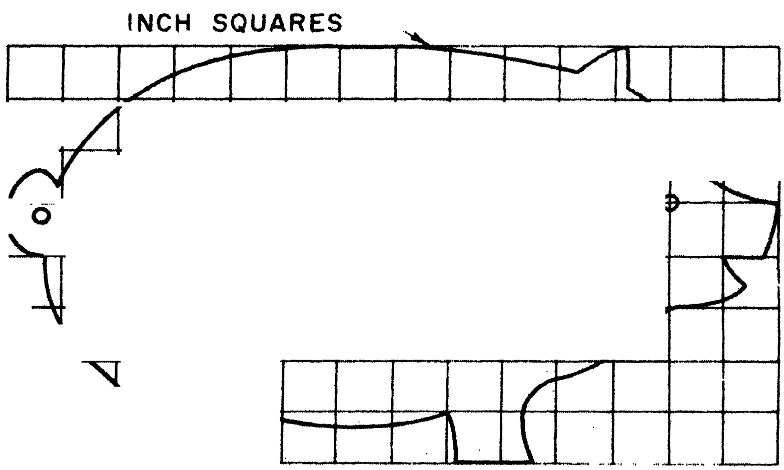
HAMMERED COPPER TRAY


BODY CROSS SECTION
NOTCH FOR WING
RUDDER
FUSELAGE — HARD BALSA
CLAY AREA FOR BALANCE
NOTCH FOR ELEVATOR
CEMENT SKIN
LEFT WING PANEL
ELEVATOR
CUT AWAY AT DOTTED
LINES FOR SWEEPBACK

I-C-8 I-C-9


$\frac{1}{2}$ INCH SQUARES





-C-10

16. This sunflower clock face would make a good modern wall clock. Can you draw it to some suitable scale? Fig. I-B-16.

17. Draw to correct shape and letter the information in these highway signs. Use some convenient scale. Fig. I-B-17.

C. Use whatever size paper is necessary to make the following drawings full size.

1. Make the layout for the parts of this cookie cutter. Fig. I-C-1.

2. Make a layout for the comb case shown in Fig. 10-2.

3. Make a full-size pattern of the design shown in Fig. 10-4.

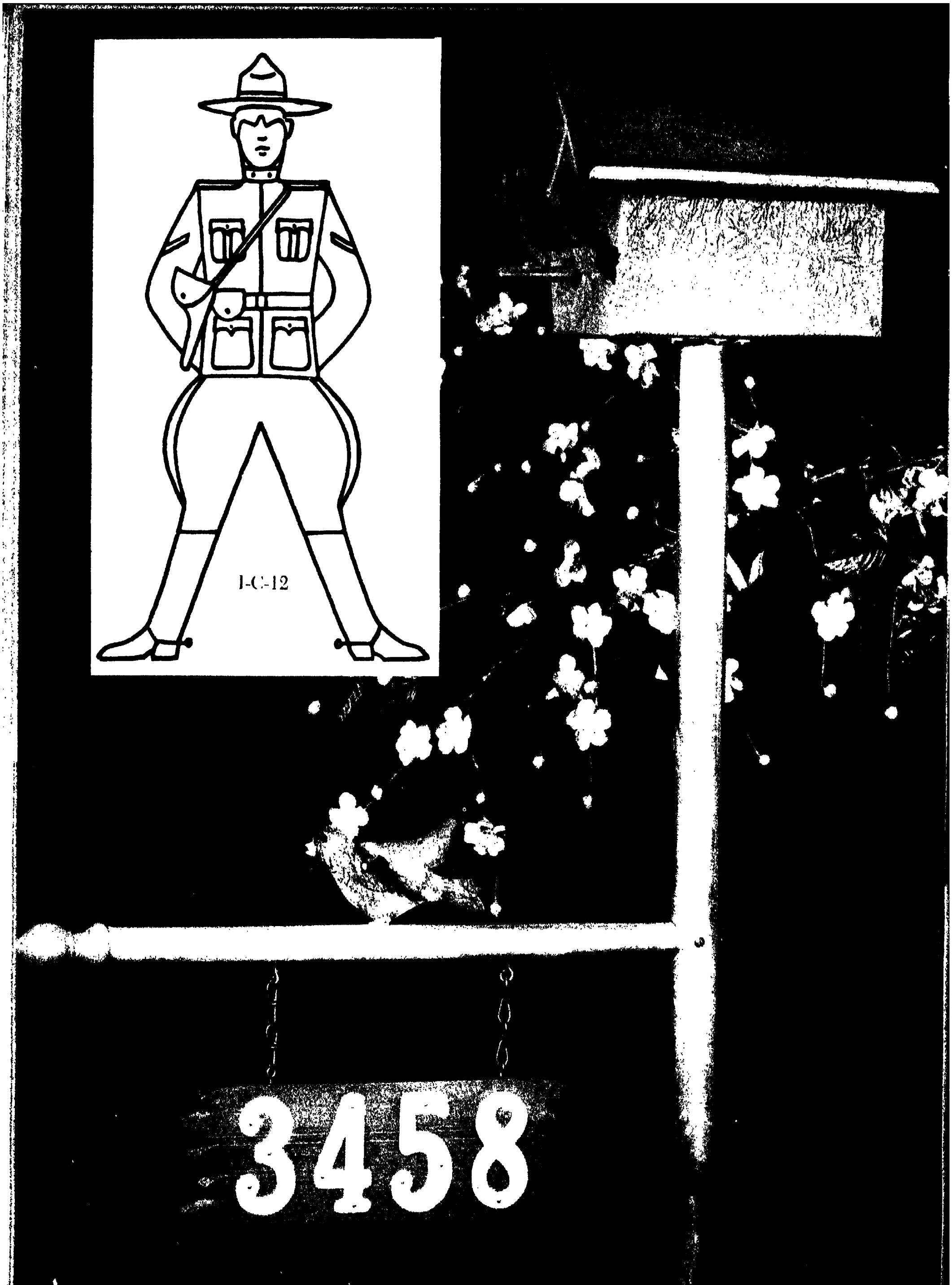
4. Make a layout for the marble box in Fig. 10-3.

5. Enlarge the fish plaque to full size. Make each square 1″. Fig. 11-4.

6. Make a full-size pattern for the parts of the tulip knife box shown in Fig. 11-2.

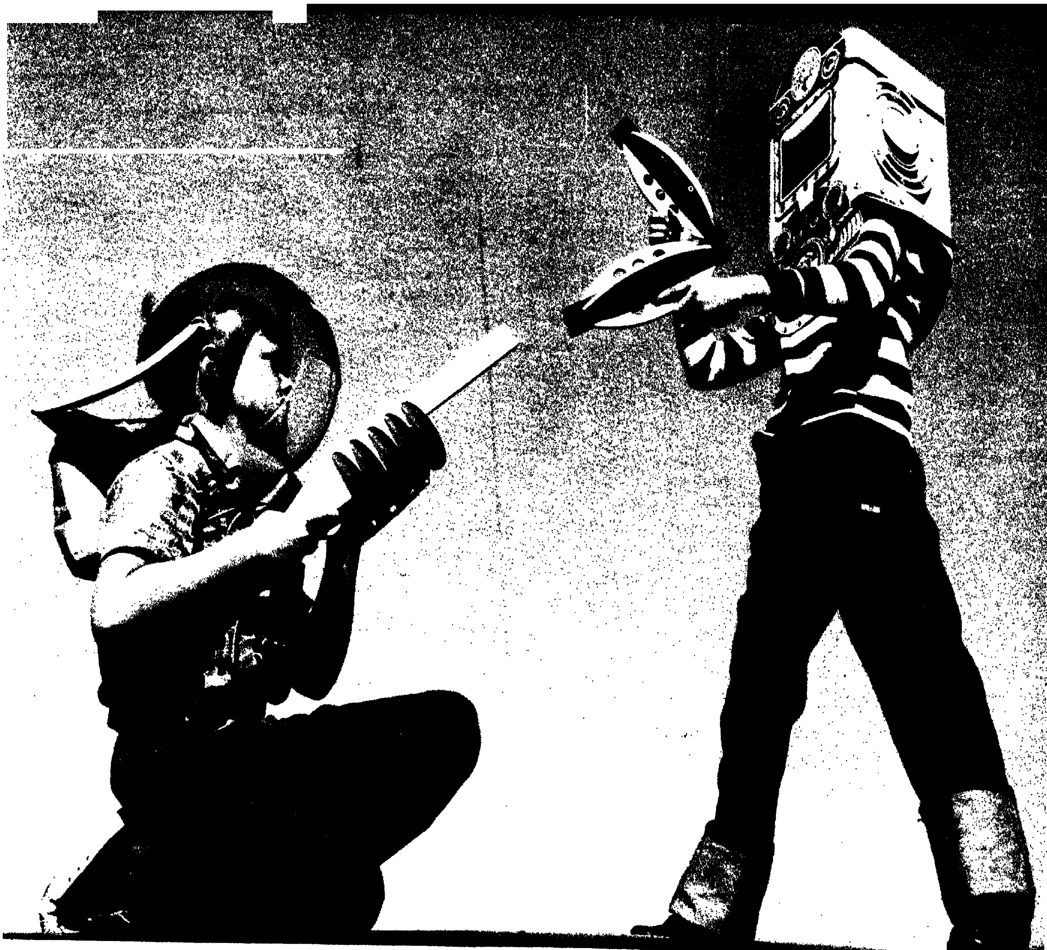
7. Draw a full-size pattern of the novelty tray shown in Fig. I-C-7.

8. Make a full-size pattern for the parts of the balsa glider. The length of the fuselage is $8\frac{5}{16}$″. Fig. I-C-8.



I-C-12

I-C-13



I-C-14A

9. Patterns for the parts of the letter holder shown in Fig. I-C-9 must be made full size.

10. Make a full-size pattern for a cutting board. Fig. I-C-10.

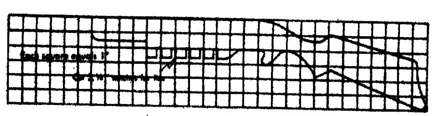
11. The coat hanger shown in Fig. 11-3 is 26" long. Make a pattern for half the back.

12. The design shown in Fig. I-C-12 is 5 inches in height. Make a full-size pattern.

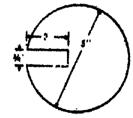
13. Make a pattern for the house numbers shown in Fig. I-C-13. The overall size of the board is 4" x 12".

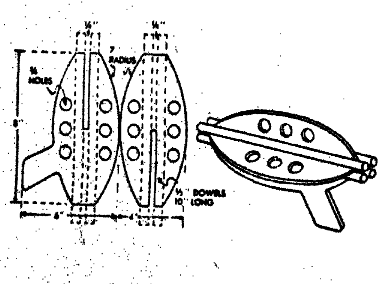
14. Complete full-size patterns for the wooden ray guns shown in Fig. I-C-14.

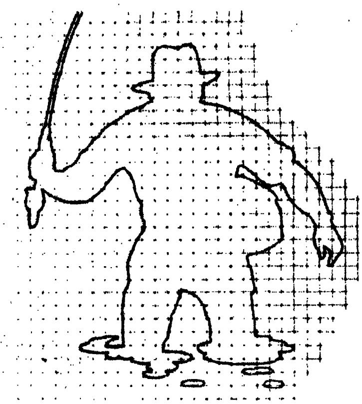
15. Make a full-size pattern on masonite of one of the outdoor scenes shown in Fig. I-C-15. Cut it out on the jig saw. Use it to decorate the wall of your room.

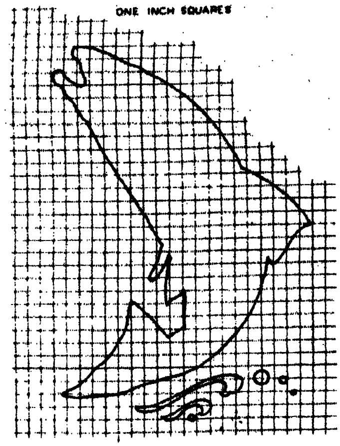


I-C-14B

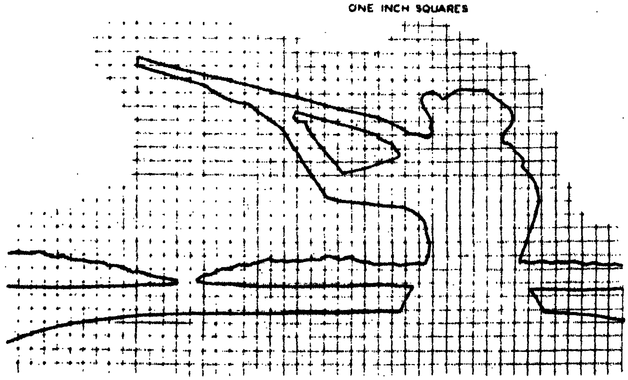


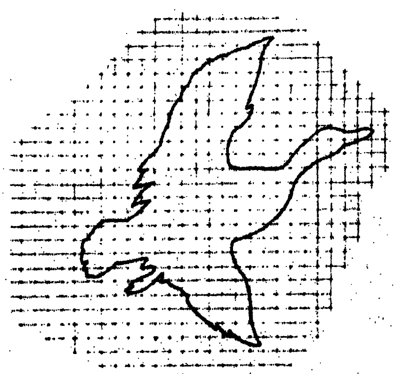


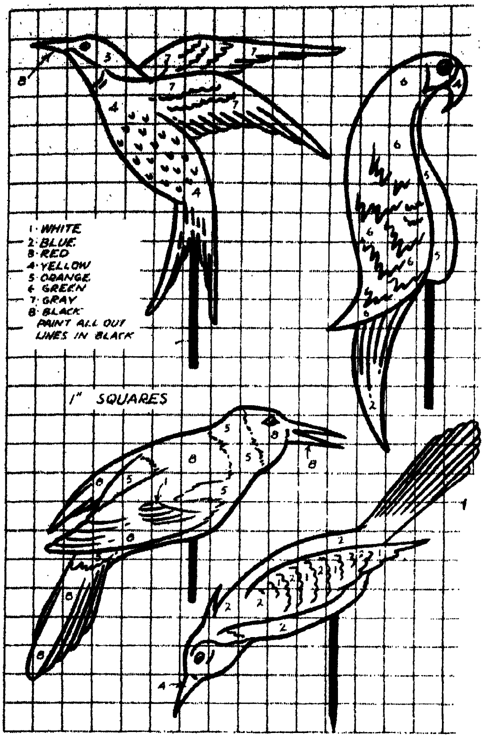




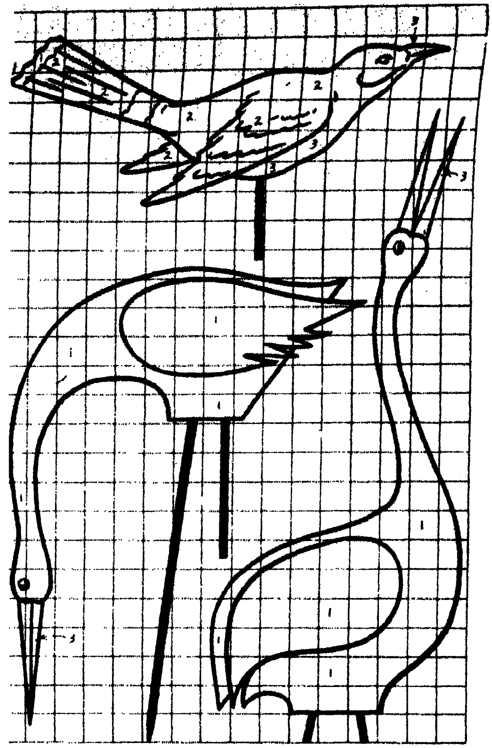
ONE INCH SQUARES







I-C-16A



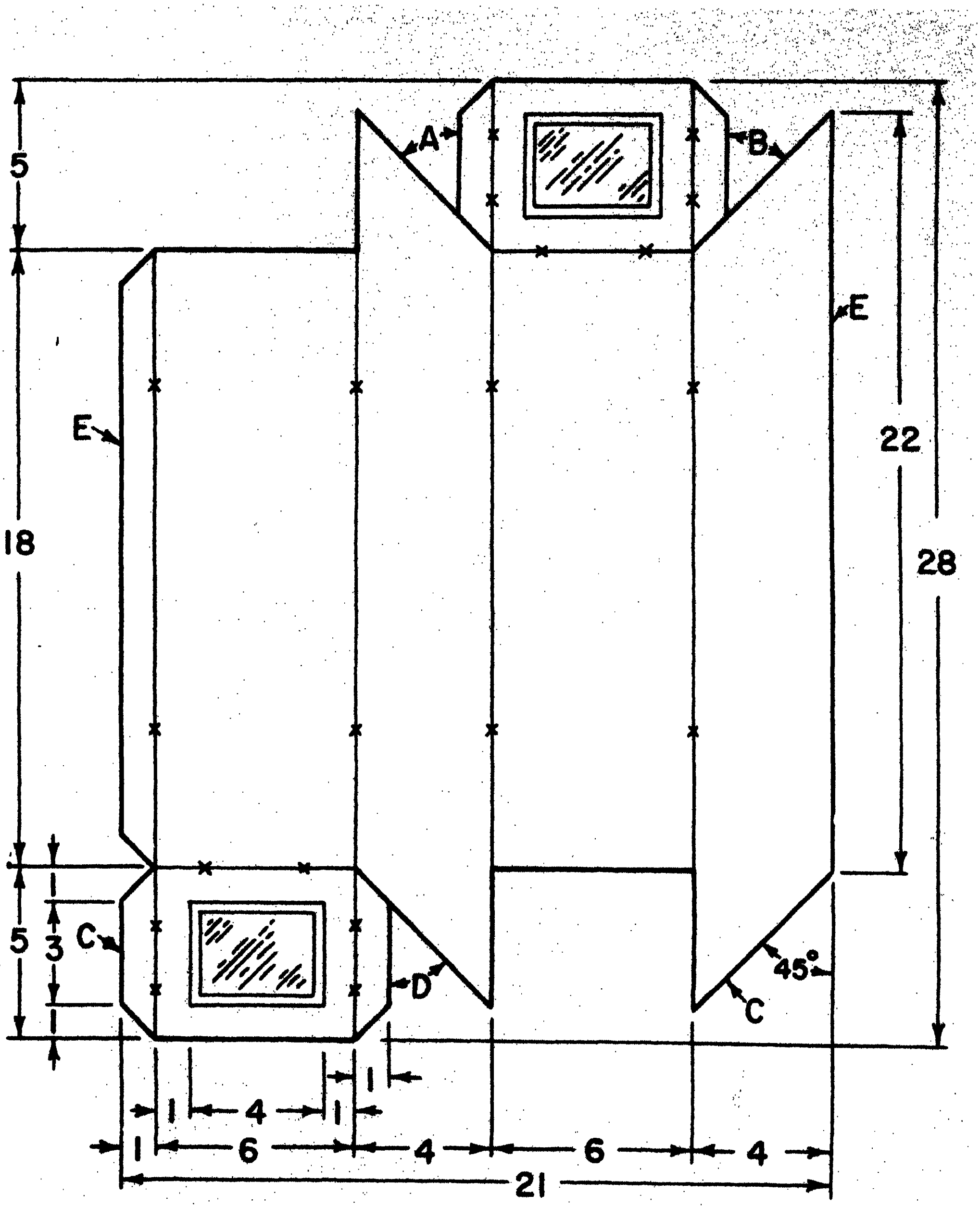
I-C-16B

16. Complete a full-size pattern for one of these bird lures. Fig. I-C-16.

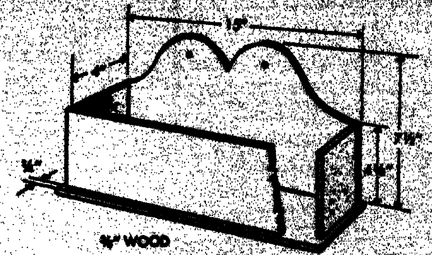
17. Make a full-size pattern on heavy cardboard of this periscope. Cut to shape and assemble. Add two small mirrors to use in it. Fig. I-C-17.

D. Make the following drawings to a suitable scale on 8 1/2" x 11" paper. Draw a border and title block or record strip on each drawing.

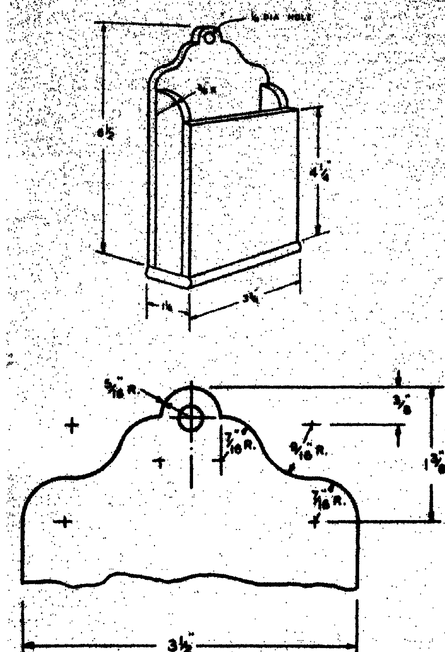
1. Make a three-view working drawing of the block in Fig. 12-14.
2. Draw the oilstone, Fig. 12-20.
3. Complete a three-view drawing of the eraser in Fig. 1-7.
4. Make a three-view drawing of the recipe card holder shown in Fig. I-D-4. All 3/16" stock except base (3/8").
5. Using Fig. I-D-5 as a guide, develop a three-view drawing of the planter box.
6. Make a two-view drawing of the candle holder in Fig. I-D-6.
7. Develop a three-view working drawing of the serving tray in Fig. I-D-7.
8. Make a full-size, two-view drawing of the yo-yo in Fig. I-D-8.
9. Make a three-view drawing of the bookends in Fig. 13-5.
10. Make a view drawing of the magazine rack in Fig. I-D-10.
11. Complete the views and add the missing lines for the items shown in Fig. I-D-11: (a) an eraser used in drawing, (b) a rabbet found in woodworking, (c) a bracelet bending form used in metalworking, (d) a piece of metal furniture used in printing and graphic arts.
12. Make a three-view working drawing of this toy house. Fig. I-D-12.
13. Make a three-view drawing of the spoon rack in Fig. 1-16.
14. Complete a two-view drawing of the towel holder in Fig. 1-28.
15. Make a three-view drawing of the wall shelf shown in Fig. 14-5. Why isn't the side view necessary?
16. Draw a two-point perspective of the clothes cabinet shown in Fig. 15-2.
17. Make an isometric to some suitable scale of the knife holder shown in Fig. 16-3.



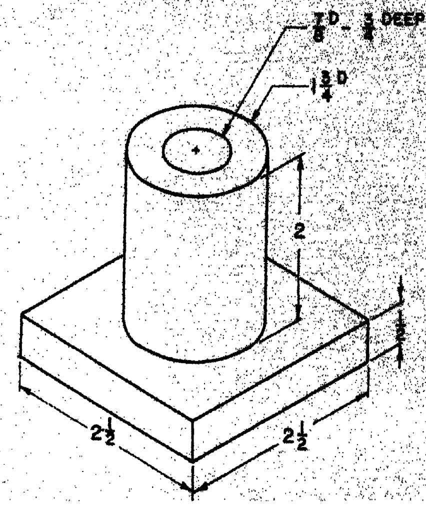
I-C-17



I-D-5

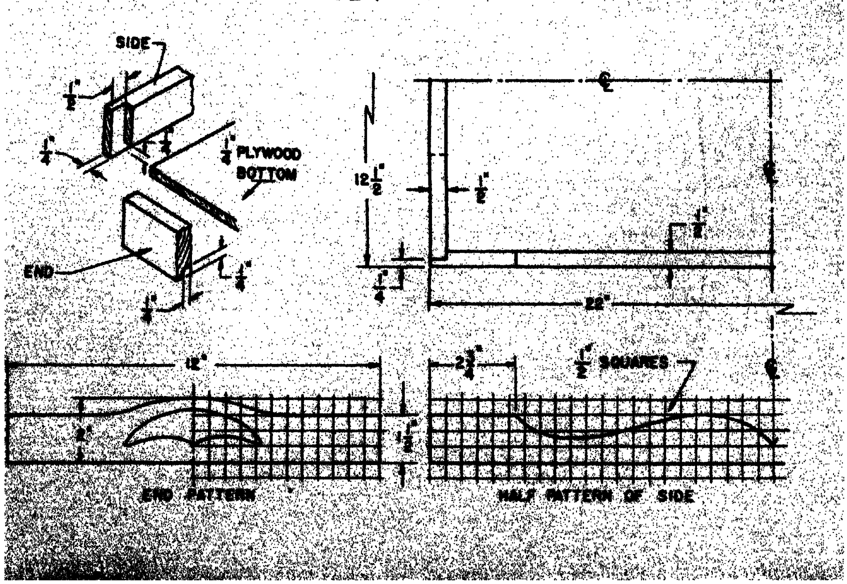


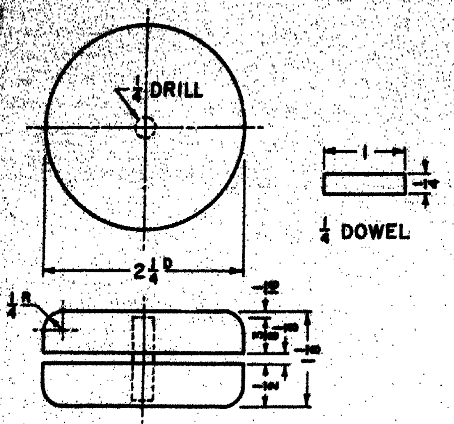
I-D-4



I-D-6

I-D-7





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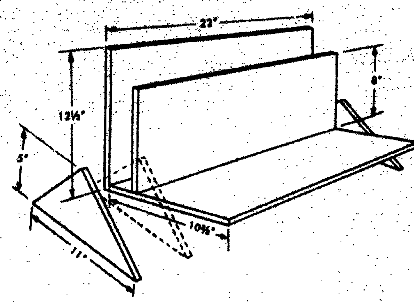
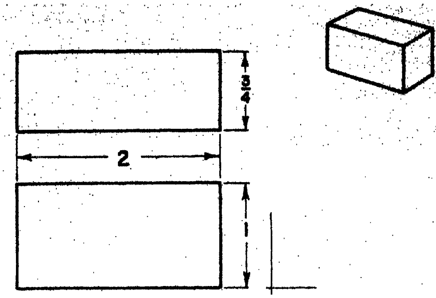


I-D-10B

I-D-10A



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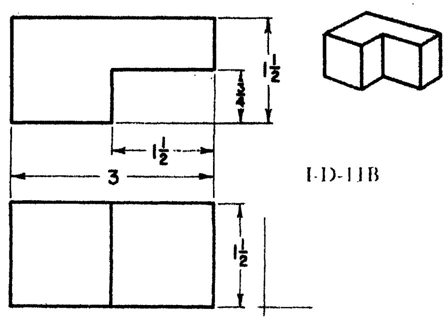

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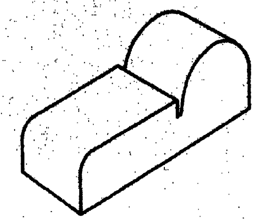

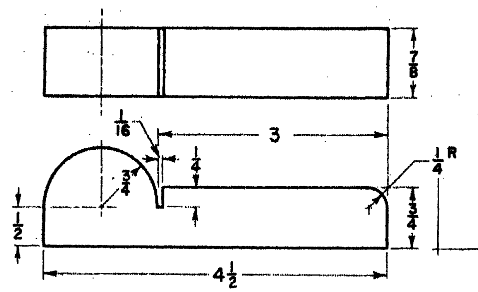

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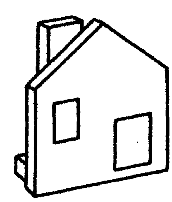
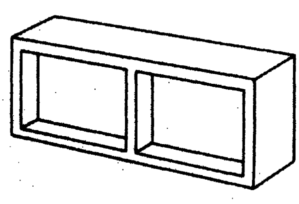
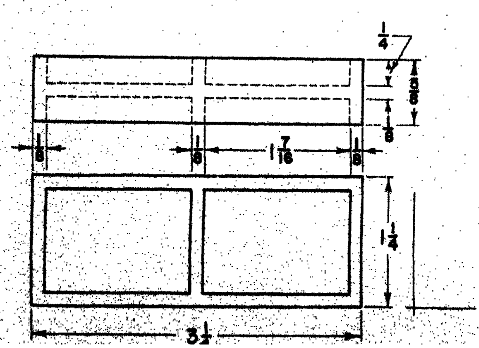
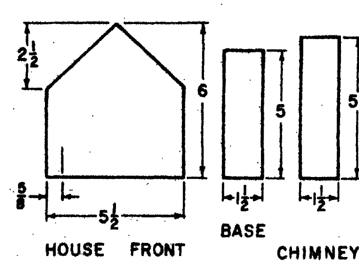
I-D-12

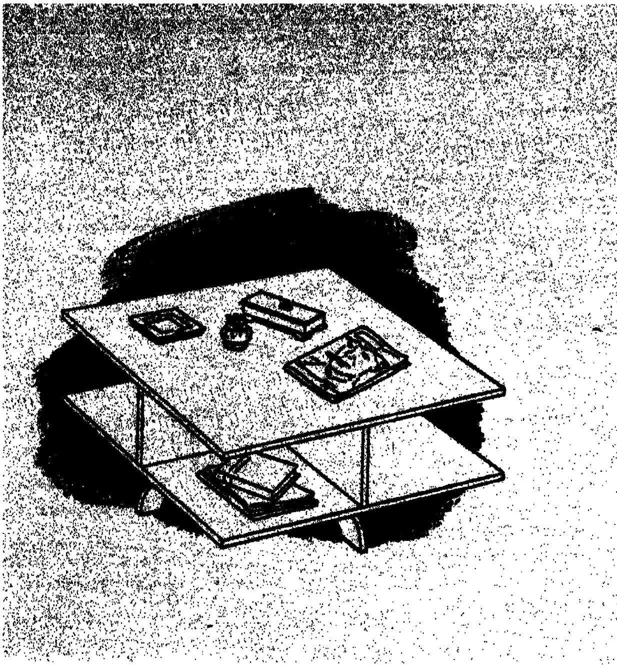




I-D-11D







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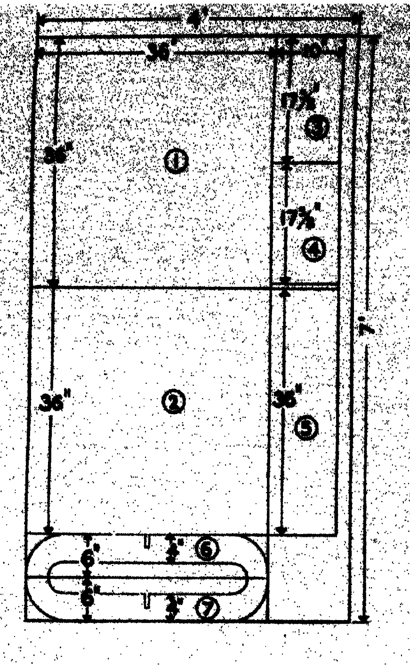

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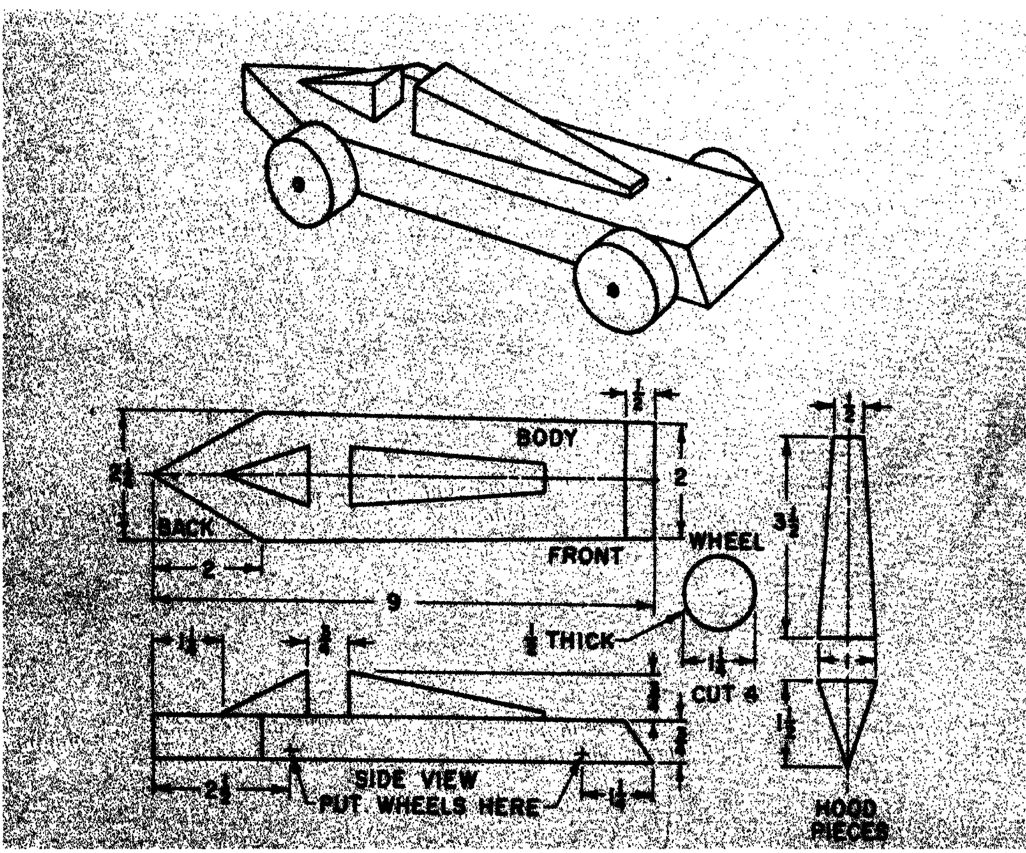
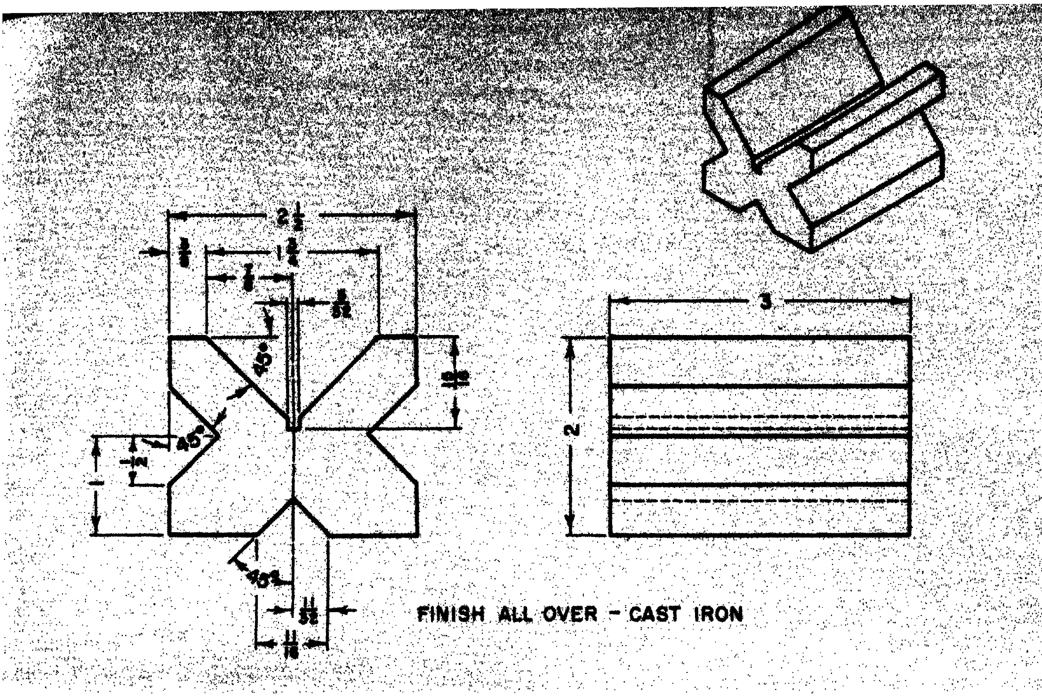
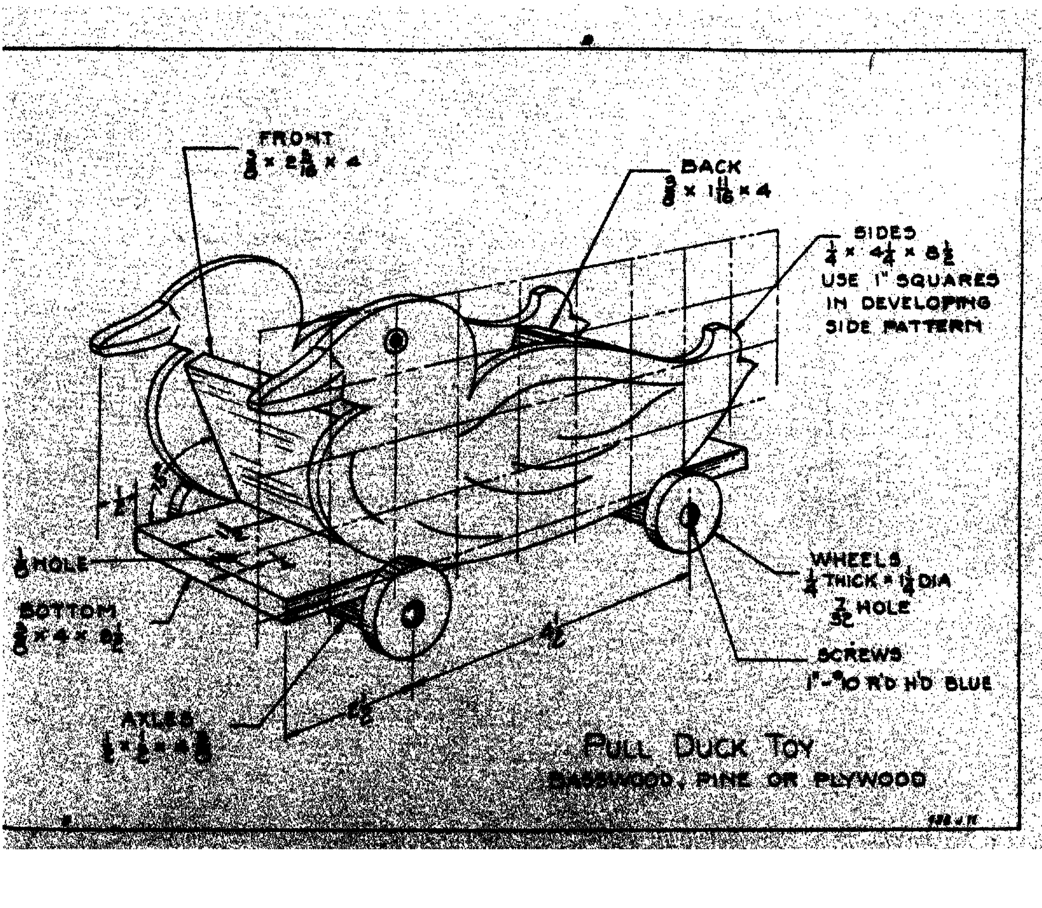


I-D-24


FINISH ALL OVER - CAST IRON

I-D-25

I-D-26-A


FRONT
BACK
SIDES
USE 1" SQUARES
IN DEVELOPING
SIDE PATTERN
HOLE
BOTTOM
WHEELS
THICK
DIA
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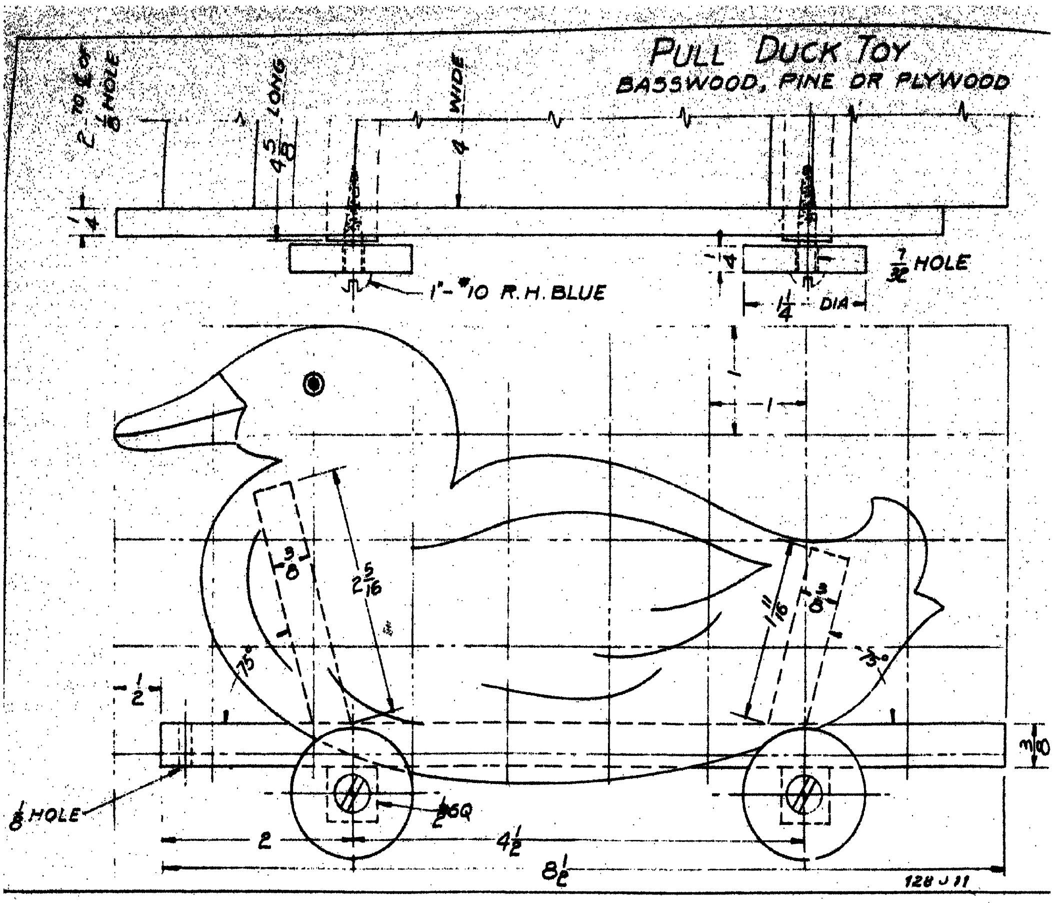
SCREWS
R'D H'D BLUE
AXLES
PULL DUCK TOY
BASSWOOD, PINE OR PLYWOOD



I-D-26-B

18. Complete a cabinet drawing of the same knife holder in Fig. 16-3.

19. Make an isometric drawing of the plastic paper weight shown in Fig. 16-4. Each side is 2".

20. Draw the candle holder shown in Fig. I-D-6 in isometric.

21. Make a cabinet drawing to some suitable scale of the cabinet shown in Fig. 17-2. The wood cabinet itself is 24" high x 18½" deep x 53³⁄₁₆" long.

22. Make an isometric drawing to some suitable scale of the coffee table shown in Fig. I-D-22. Add the dimensions by using the information shown in the cutting diagram. ¾" plywood.

23. Complete the drawing for the seat detail shown in Fig. 18-1.

24. Make an assembly drawing of the racer shown in Fig. I-D-24.

25. Complete a cabinet drawing full size of this V-block. Fig. I-D-25.

26. Complete a two-view drawing of this pull duck toy from the isometric drawing as shown in Fig I-D-26.

Section II: SKETCHING, DESIGNING, AND PLANNING

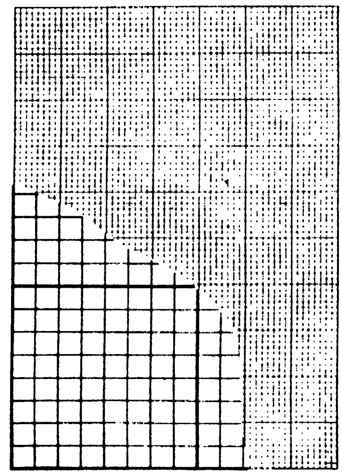
HERE is a *preview* of the things you will learn in *sketching, designing, and planning* . . . what you should know and be able to do after you have studied the units in this section:

1. How to make a shop sketch.
2. How to make an isometric shop drawing.
3. Freehand sketching and how to begin.
4. How to draw lines, squares, rectangles, triangles, circles, and arcs freehand.
5. How to make cabinet and isometric sketches freehand.
6. What it means to *sketch* in perspective.
7. How to use a plastic template for making perspective sketches.
8. Commercial sketches and how they can help you.
9. Good design in the shop.
10. What makes up design.
11. The principles of design arrangement.
12. Designing a project.
13. Planning a project construction.
14. What the bill of materials is.
15. What it means to "plan your work, then work your plan."

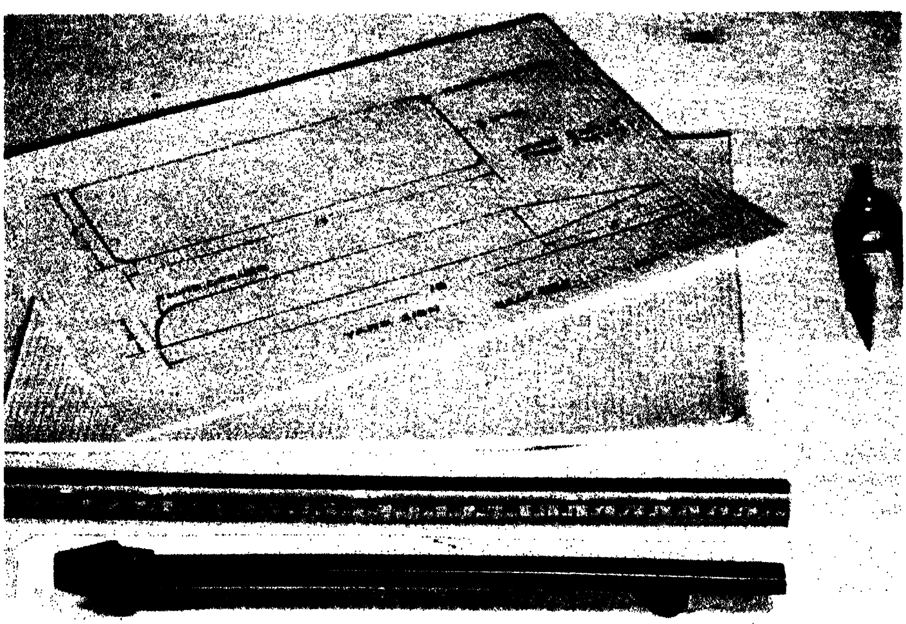
Section II

19. Making A Shop Sketch

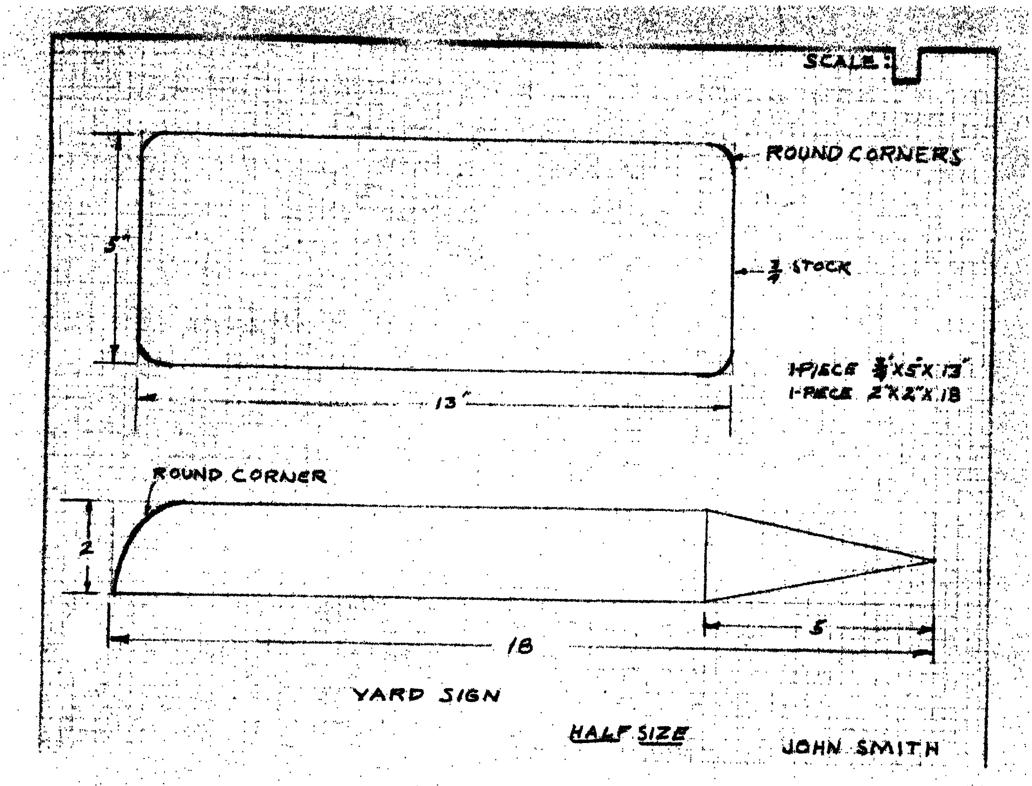
In your workshop you need a simple drawing of each project you are going to build. These simple drawings, sometimes called shop sketches, are made on squared paper. They are used mostly by the person himself



19-1. Squared, or cross-section, paper usually has four or eight squares to the inch with an extra heavy line outlining the inches.



19-2. The tools and materials needed to make a shop sketch.



19-3. A simple shop sketch of a yard sign. As shown here, the scale is half size.

as he works in the shop. If several people are going to use it, this sketch should be made into a mechanical drawing. *Shop sketches* are easier to make than *freehand sketches.* This is true because it is hard to judge size and proportion when sketching on plain paper. The only materials and tools you need are:

1. Materials: Squared or cross-section paper. This paper is lined in squares, usually 4 or 8 to the inch. Fig. 19-1. These squares help you to find the size of the object and to keep your lines straight. Sometimes paper with dots spaced ¼" apart is used.

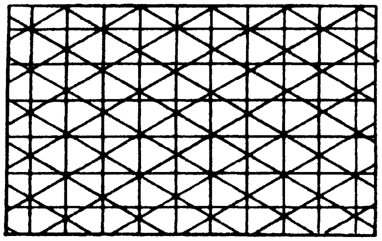
2. Tools: A medium soft H or HB pencil, an eraser, a 12-inch rule or straightedge, and a pencil compass (if desired). Fig 19-2. The compass may be used for drawing circles and arcs. These can be sketched freehand, however.

MAKING A SHOP SKETCH

1. Secure a piece of cross-section paper.

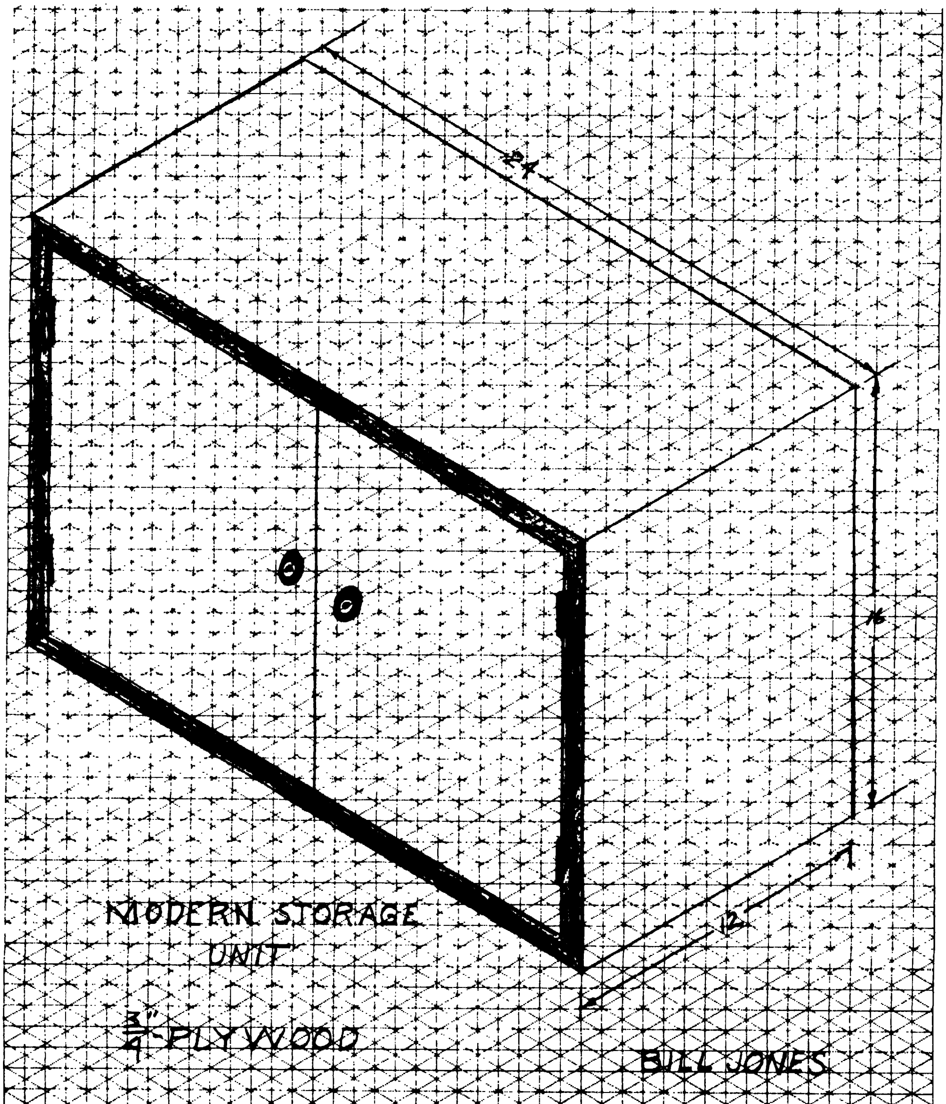
2. Decide on the views you need to build the project. Often one view of each part is all that is needed.

3. Determine the scale. Decide if you can make the drawing full size, half size, or some other scale. If there are 8 squares to the inch, each square can represent ⅛", ¼", ½", or any other fraction. For example, suppose you



19-4. Isometric cross-section paper. The guide lines on the paper make it easy to draw an isometric.

19-5. A modern storage unit drawn in isometric.



want to make a shop sketch of this yard sign: Fig. 19-3. Note that the post is 18″ long and the board is 13″. If it is drawn half size, both parts of the sign will go easily on 8½″ x 11″ paper. On paper with 8 squares to the inch, each square will represent ¼″.

4. Complete the drawing.

a. Draw the post. The post is 2″ square and 18″ long. Start about 1½″ up from the bottom of the page and in from the left edge about 1″. Mark a point. Draw a light horizontal line that represents the overall length of the post, or 9″. Draw a light vertical line for the thickness, 1″. Complete the rectangle. Measure in 2½″ from the right and measure up ½″ from the lower right corner. Draw the point at the end of the post. Round off the opposite corner either freehand or with a compass. Darken in the outline. Draw the extension and dimension lines.

b. Make a one-view drawing of the board in the same general way.

c. Add the dimensions and notes. Notice that the lines and lettering aren't as perfect as you would make them in mechanical drawings. They are good enough for your own use, however. Remember this: to be useful the drawing or sketch must be correct. It doesn't have to be beautiful. It's a good drawing if you can build the project with it.

MAKING AN ISOMETRIC SHOP DRAWING

Another kind of paper is called isometric cross-section paper. It has lines drawn at angles of 30-60 degrees for making isometric drawings. Fig. 19-4. These are made in the same way as view drawings.

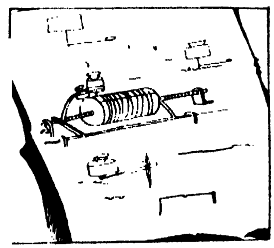
Suppose you want to make an isometric drawing of this modern storage unit. Fig 19-5. It is 16″ high, 12″ wide and 24″ long. It is necessary to use a scale of one fourth size (3″ = 1′). Begin the drawing about two thirds of the distance over on the page. Draw a vertical line that is 4″ long (height). Draw a line at 30 degrees to the right that is 3″ long (width). Draw a line at 30 degrees to the left that is 6″ long (length). Complete the drawing as described in Unit 16, Section I, "Isometric Drawings." This paper eliminates the need for T square and triangles.

Section 11

20. Doing Freehand Sketching

When Thomas Edison got the idea for the first phonograph, he made a freehand sketch of the design and gave it to one of his workmen to build. Fig. 20-1. Just imagine, the first phonograph that worked was built from a simple sketch! Freehand sketching is a skill you can use every day of your life. There are always a piece of paper and a pencil handy. These are the only tools and materials you need to express your ideas on paper. For example, you might want to sketch a play in football or a project you'd like to build or a simple map showing a friend how to get to your house. Fig. 20-2.

It's not easy to make good sketches. It takes a lot of practice. To sketch well you must be able to make good smooth lines, both straight and curved, freehand. You must also learn to judge distances to get proper proportion. With time and patience you can learn to sketch well.



20-1. Here is a copy of the sketch Thomas Edison made for the first phonograph.

TYPES OF LINES

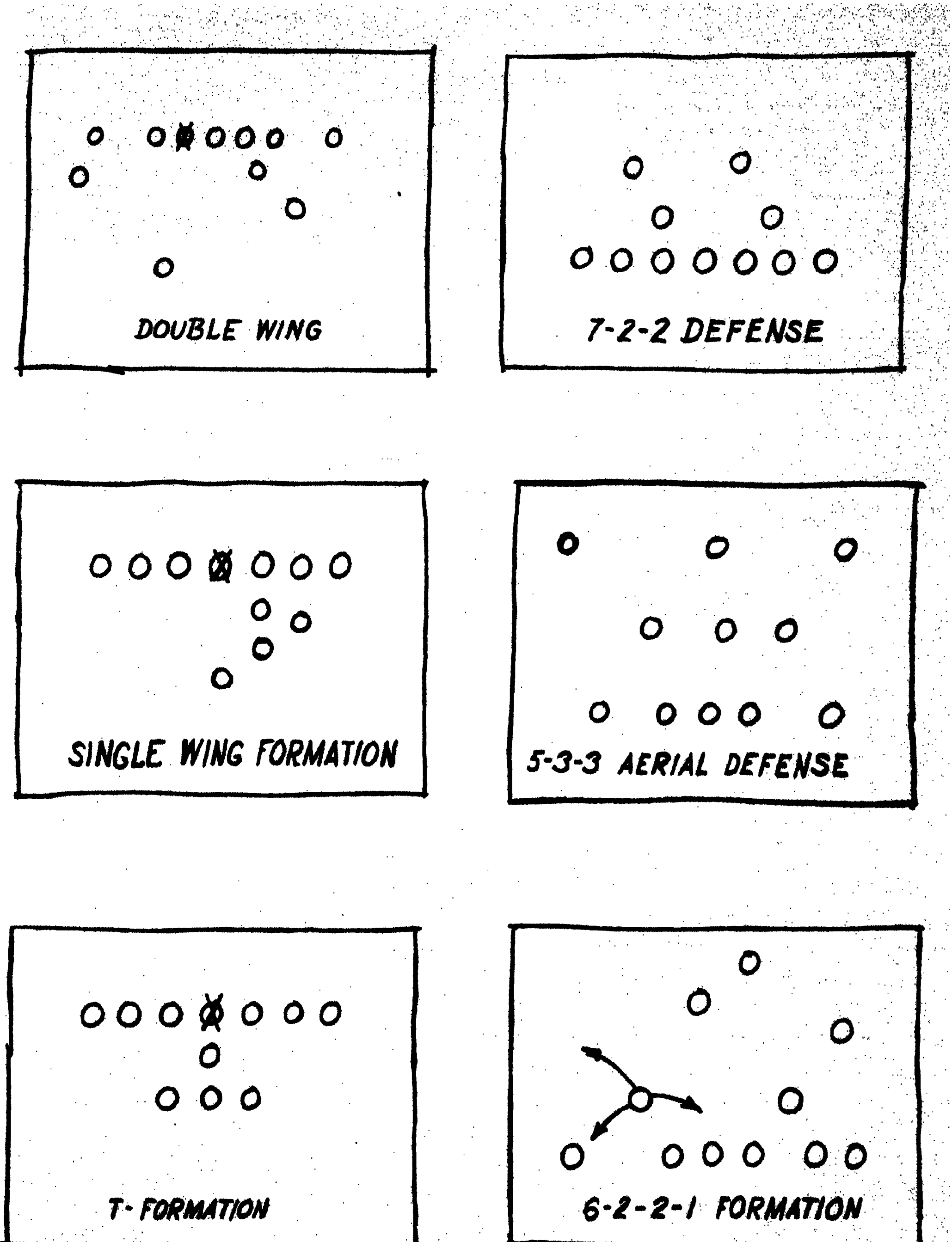
The lines for freehand sketching are the same as those for mechanical drawing. Fig. 20-3. The outline and hidden lines are made quite heavy. The other lines are lighter. Make the construction lines so light that they do not need to be erased.

DRAWING STRAIGHT LINES

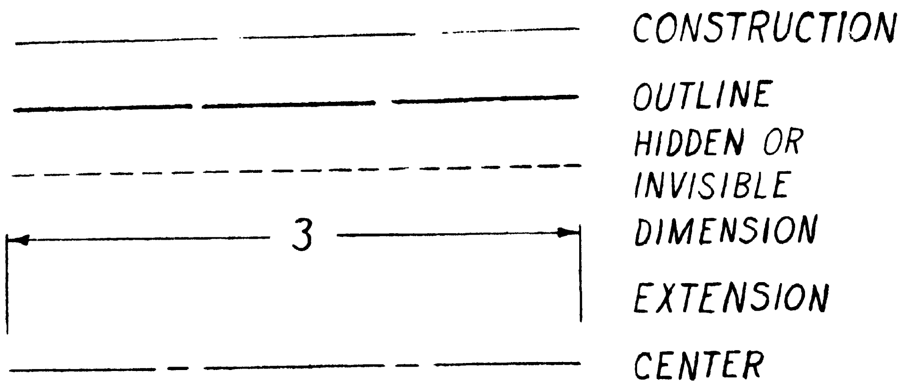
1. Use a piece of plain white 8½" x 11" paper. Have a sharp HB pencil and an eraser handy.

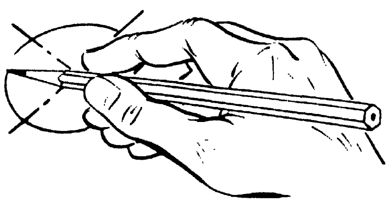
2. Hold the pencil loosely in your hand about ¾" to 1" away from the point. Fig. 20-4. Pull the pencil along as you sketch. Don't push it.

3. To draw horizontal lines, place a point at the beginning and end of the line. You might try starting at one point and drawing short strokes as you move your hand along. Unless you are especially talented, do not try to draw a single straight line in one stroke because then your arm moves and the line becomes curved. Go over the series of short strokes to make the line solid. Practice this



20-2. How sketching is used in football for diagramming some of the common plays.

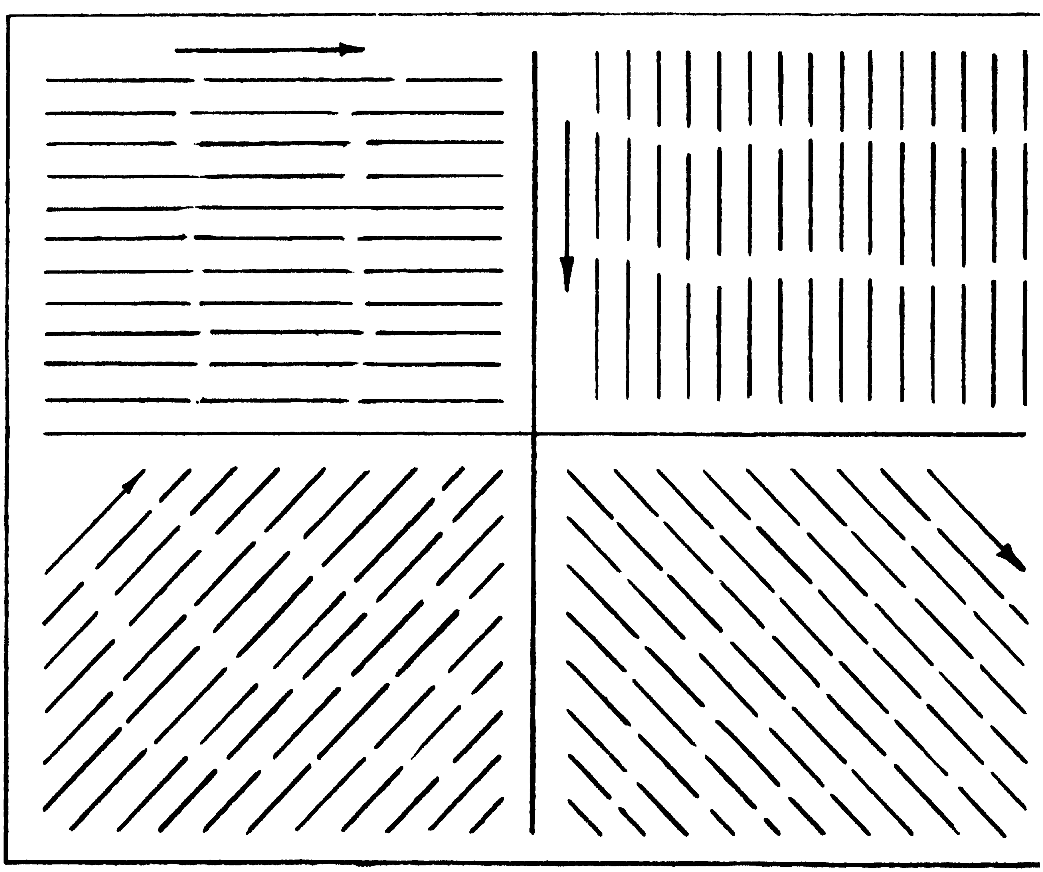


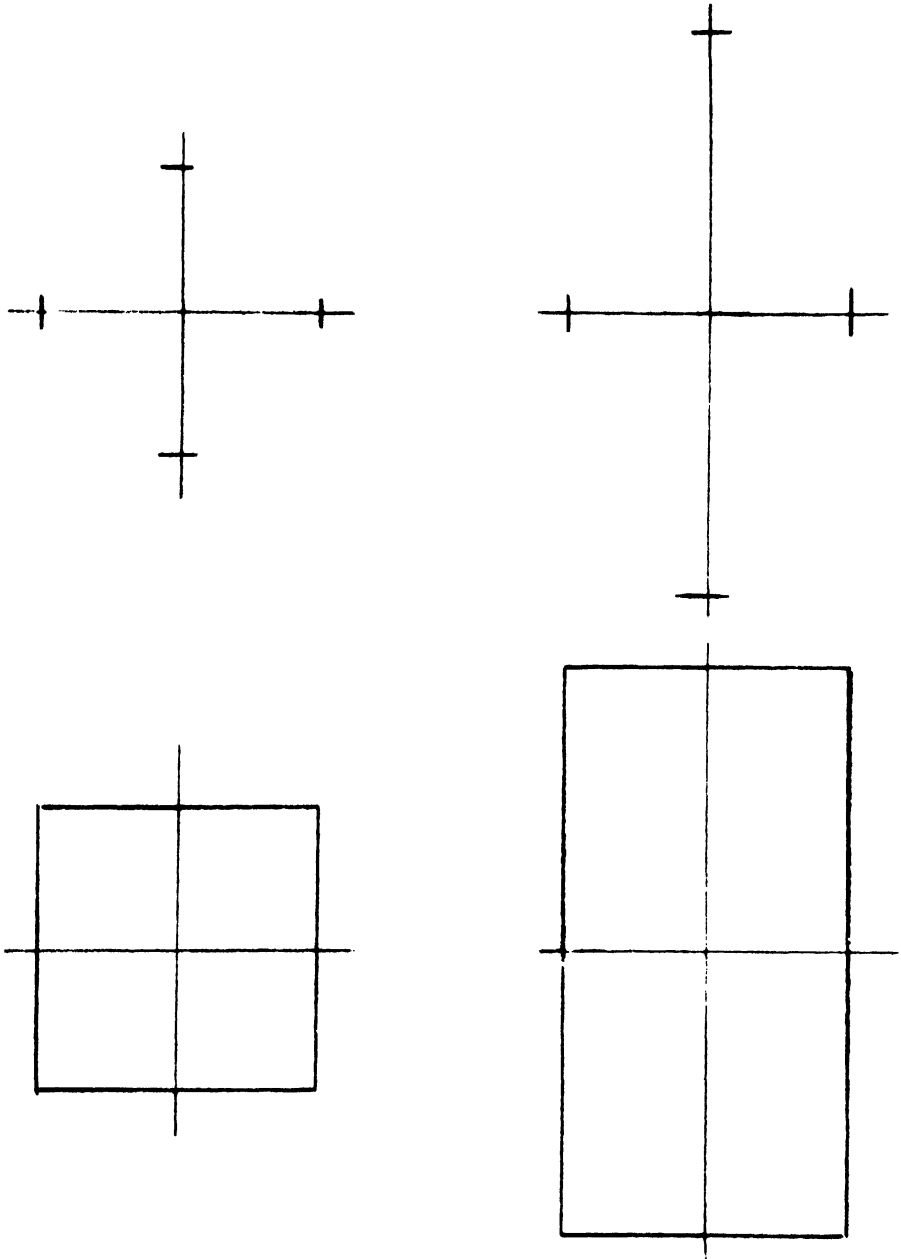


20-3. The lines in freehand sketching are the same as in mechanical drawing.

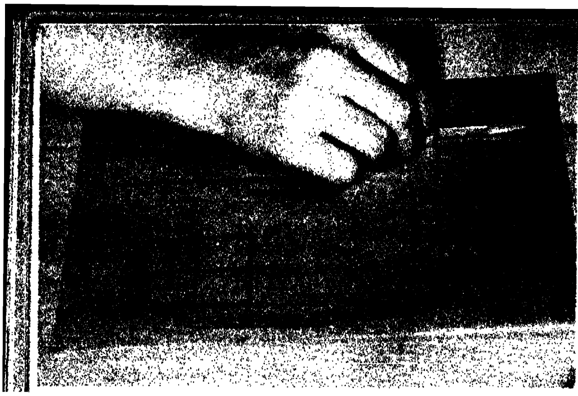
20-4. The correct way to hold a pencil for sketching.

20-5. The way to sketch lines. The arrow shows the direction your pencil should follow.





20-6. Sketching a square or rectangle.



20-7. Using a pencil as a guide in sketching. This will help you to get good proportion.

to see if you can draw a series of straight parallel lines.

4. To draw a vertical line, place a point at the upper and lower ends of the line. Line up the points with your eye as a carpenter does in sighting along the edge of a board. Draw the pencil toward you from the top to the bottom. (A second method is to move the paper so that all lines are drawn in a horizontal position.)

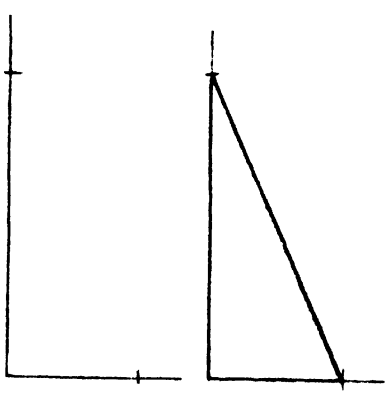
5. Draw slanted or inclined lines in the same way, following the directions shown by the arrow in Fig. 20-5.

SKETCHING SQUARES AND RECTANGLES

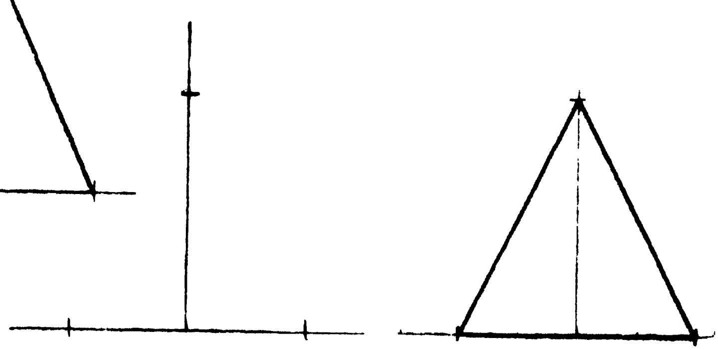
1. Draw light vertical and horizontal construction lines that intersect in the center. Fig. 20-6.

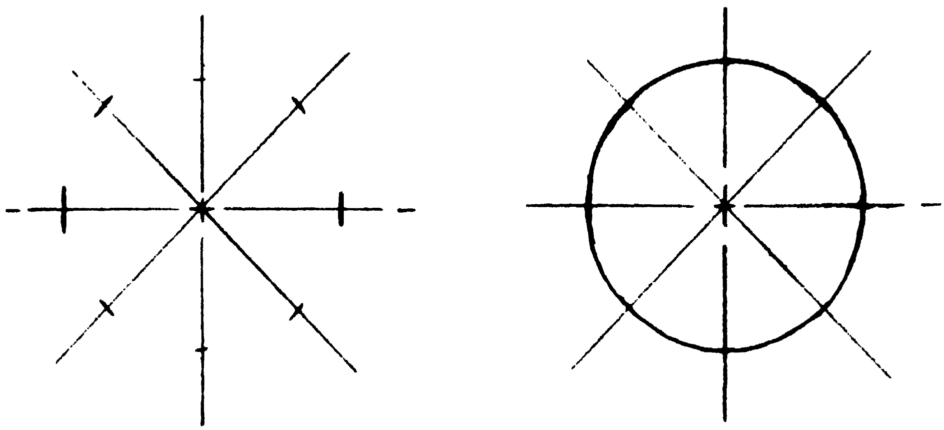
2. Mark a point on these lines to show the approximate width and length of the object. You may measure from the intersecting lines an equal number of spaces for drawing a square. Use your pencil in sketching as a measuring or judging tool. For example, suppose the rectangle is twice as long as it is wide. Place your fingers on your pencil a distance from the point equal to the width of

20-8. Sketching a right triangle.

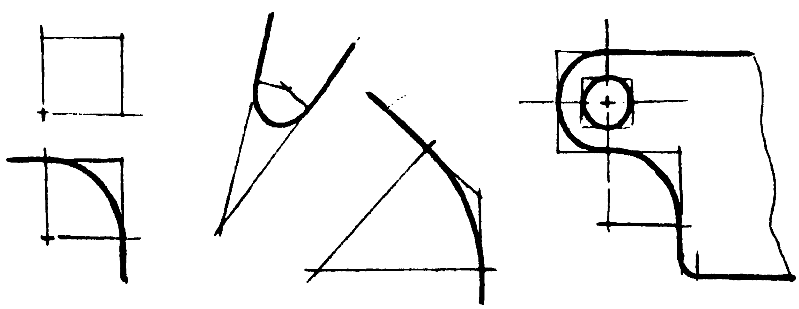


20-9. Sketching an equilateral triangle.





20-10. Sketching a circle. Extra lines are sketched at 45 degrees to the horizontal so that you can get a smooth curve.



20-11. Sketching curves and arcs by blocking in.

the rectangle. Turn the pencil sideways and twice that amount is the length. Fig. 20-7.

Draw light vertical and horizontal lines to form the square or rectangle. Fig. 20-6. Go over the lines to darken them. Do not erase the construction lines.

SKETCHING TRIANGLES

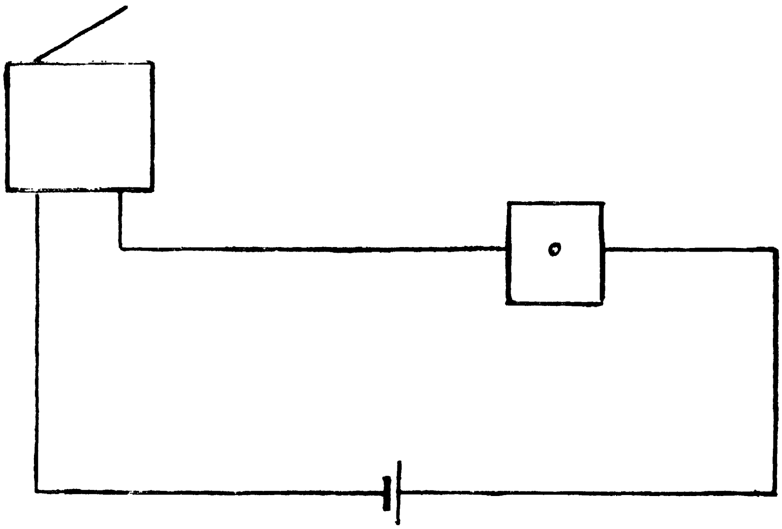
1. Sketch light vertical and horizontal lines that intersect at one corner. Mark off one leg of the triangle along a vertical line and another leg along the horizontal line. Judge distances with your pencil.

2. Draw in the heavy vertical, horizontal and slanted lines to complete the triangle. Fig. 20-8.

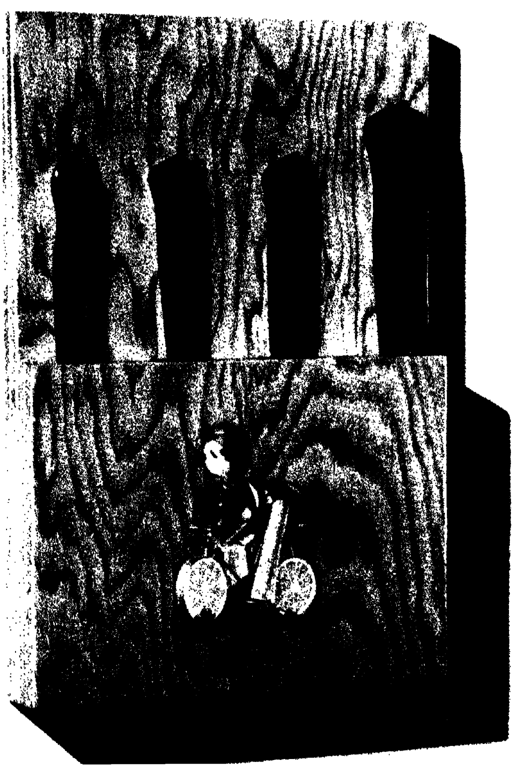
3. An e q u i l a t e r a l triangle is sketched as shown in Fig. 20-9.

SKETCHING CIRCLES AND ARCS

A circle is the most difficult shape



20-12. This is the way to make a schematic sketch in electricity.



to sketch. Most of your first circles will look pretty wobbly and lopsided.

1. Draw light vertical and horizontal lines that intersect in the middle. For an even, smooth circle, draw lines at 45 degrees that intersect at the center. Fig. 20-10.

2. Judge the radius of the circle on your pencil. Hold your fingers at the center and make a small dash on each of the construction lines to outline the circle.

3. Join these marks with smooth, even curves to complete the circle.

4. Sketch an arc in the same general way. Fig. 20-11.

20-13. Photograph and perspective drawing of a simple knife rack.

a

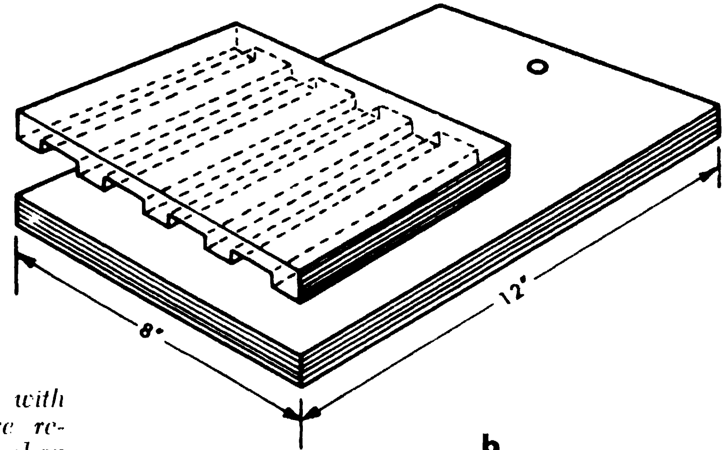
1 piece 8" x 12" x 3/4"

1 piece 8" x 6" x 3/4"

Ply Panel grade Interior fir plywood

Make knife slots by sawing 3/8" deep, rout out with chisel, width to fit your knives.

Note: All drawings with inch marks (") were received from homeshop periodicals.



20-13

MAKING A FREEHAND SKETCH

Most sketches that you will use in shopwork are view drawings. Fig. 20-12. Follow the suggestions given above in making the sketch. To make a sketch of this knife rack you would need a sketch of each part: Fig. 20-13.

1. Sketch the back of the knife rack. Determine the approximate size or scale. The back is 8" wide and 12" long. In other words, it is about 1½ times as long as it is wide. Make the sketch about *half size*.

2. Mark a point about 1" in and about 1" up from the lower left-hand corner of the paper. Use this as a starting point for your sketch. Mark another point directly above it to represent the width of the back.

3. Using your pencil as a gauge, lay off a horizontal distance about 1½ times this amount. Mark a point to show the end of the line.

4. Place another point above it to represent the other corner.

5. Sketch the light vertical and horizontal lines. Go over the lines to darken them. Decide on the size and location of the hole and sketch it.

6. You can sketch an end view if you want to. This is not necessary, though, since the thickness can be shown by a note.

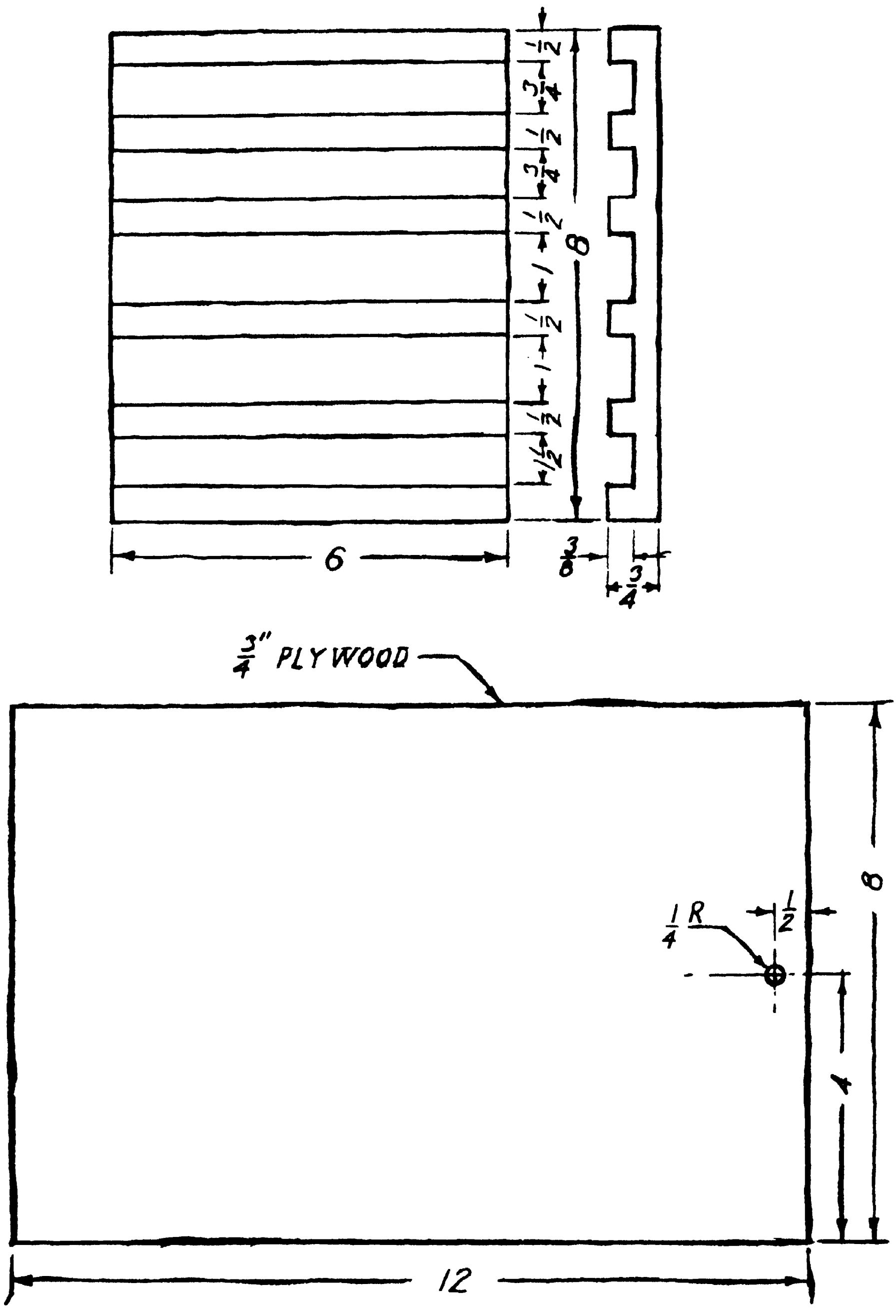
7. Letter in the dimensions and any notes that are needed. Fig. 20-14.

8. Make a sketch of the front of the knife rack in a similar manner.

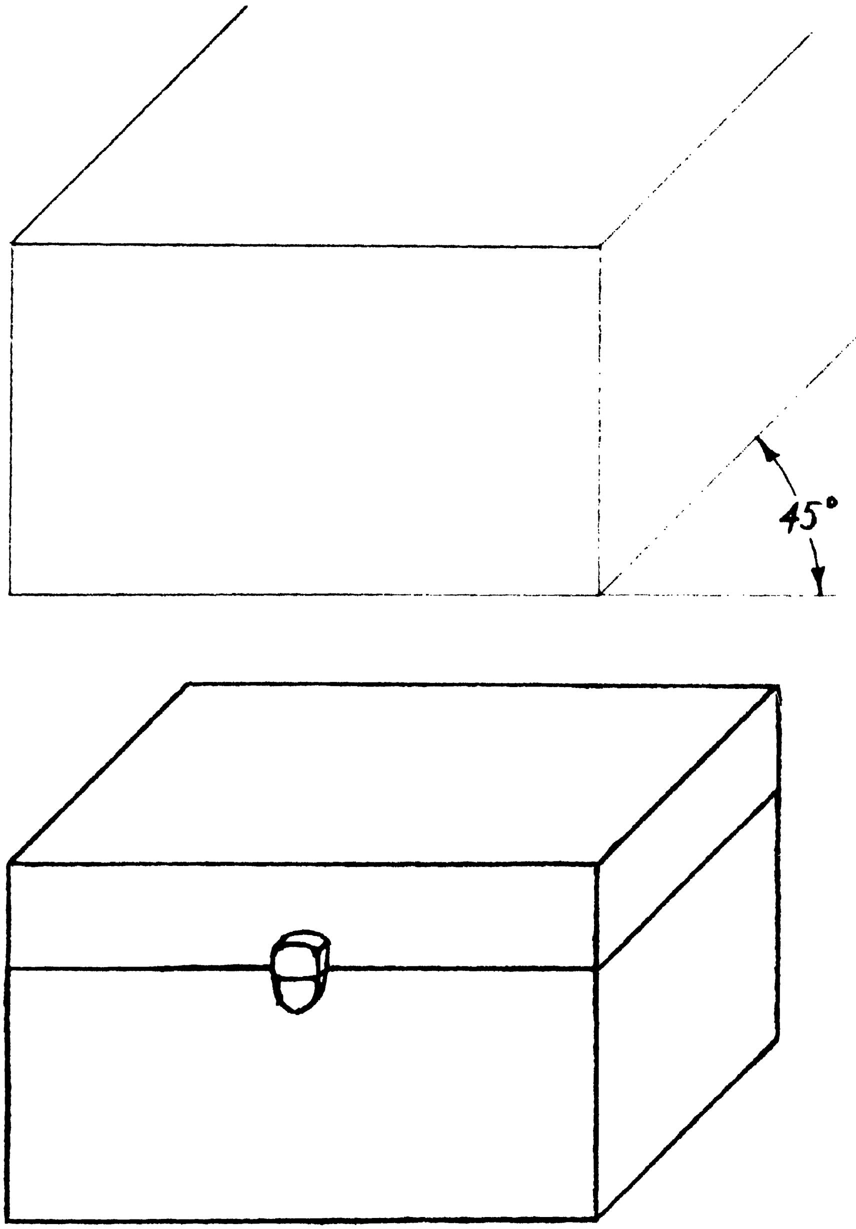
MAKING CABINET AND ISOMETRIC SKETCHES

Cabinet and isometric sketches are made in the same way as view sketches.

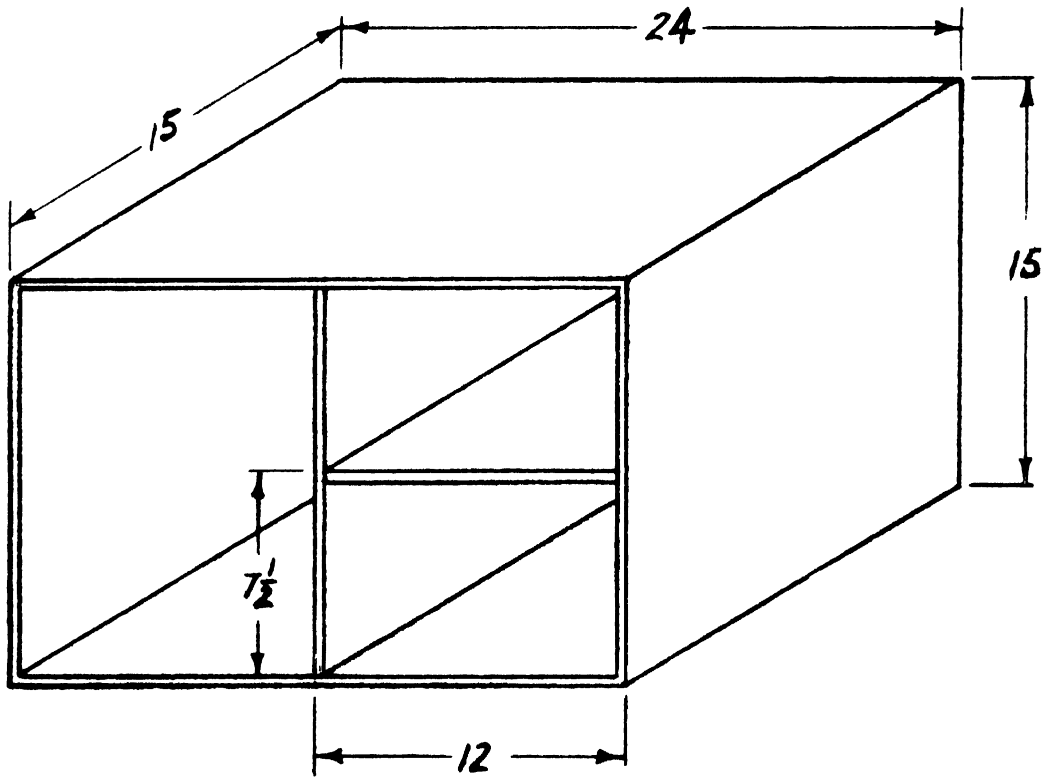
To make a cabinet sketch of a box or shelf, draw light vertical and horizontal lines to represent the front of the box. Fig. 20-15. Then sketch inclined lines for the top and side. Along the inclined line judge a distance that is about half the true



20-14. Working sketch of the knife rack.



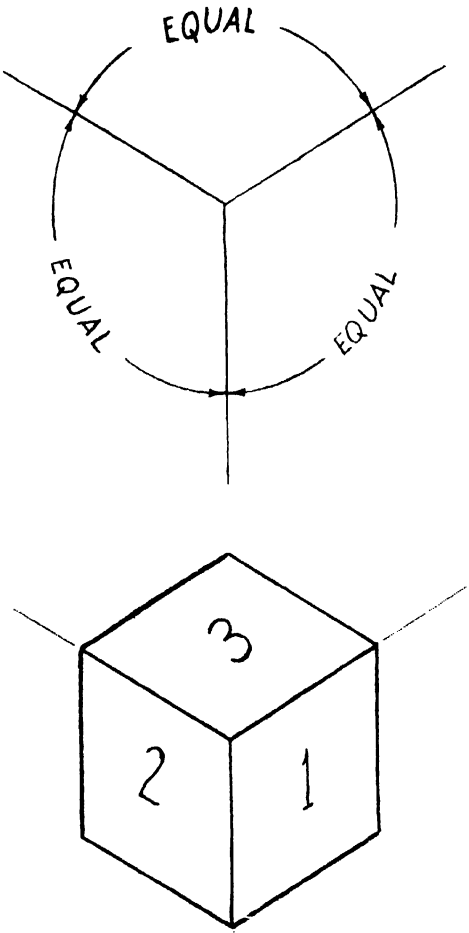
20-15. Making a cabinet sketch.



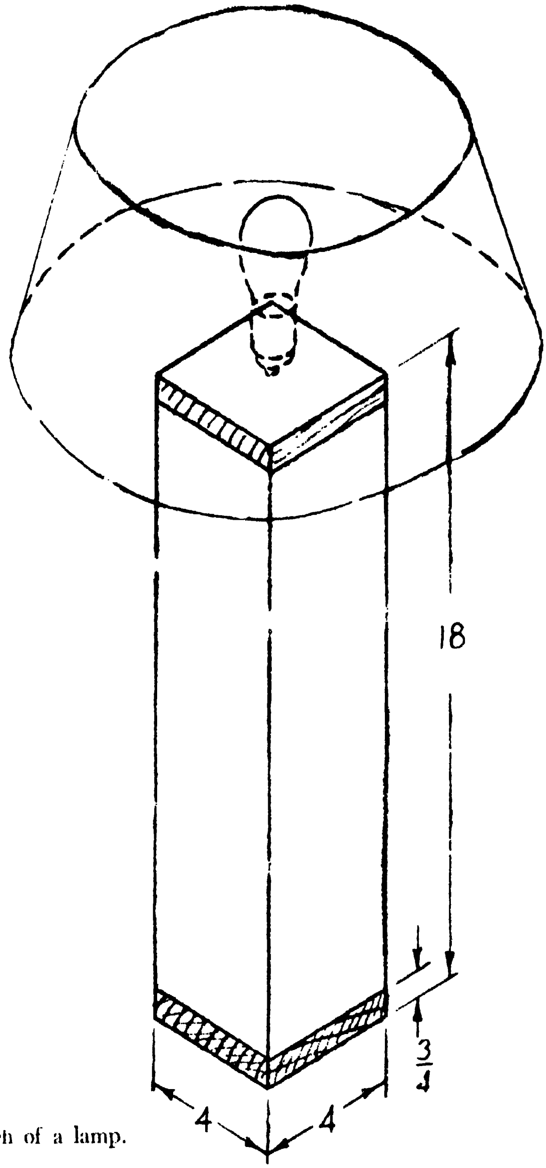
20-16. A sketch of a shel

length. Go over these lines to outline the box. See Unit 17. Fig. 20-16 shows a shelf sketched.

Isometric sketches are made around three lines that are equal distance apart. Fig. 20-17. Judge distances along these lines and then sketch in the object. See Unit 16, Section I. Fig. 20-18.



20-17. Sketching an isometric



20-18. An isometric sketch of a lamp.

Section II

21. Making a Perspective Sketch

The first step in designing anything new is to make a perspective sketch. This gives an idea of how the thing will look when completed. New cars, planes, houses, people, trees, and appliances are only a few of the objects that can best be shown in perspective. Fig. 21-1. You cannot measure any lines for actual length in a perspective, but it makes a better picture than any other method.

You will want to make a perspective sketch whenever you wish to see how your new idea looks on paper. It also helps you to show others what you have in mind so they can easily understand it.

21-1. This is a typical perspective sketch used in advertising.

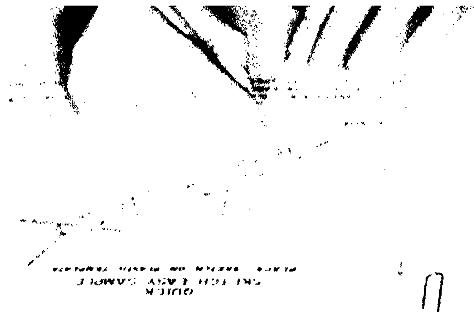
Perspective sketches use the same basic idea followed in making perspective drawings. See Unit 15, Section I. That is, they are based on one or two (usually two) vanishing points. If you are experienced and the project is fairly simple these sketches can also be used as construction drawings, since, with dimensions, they are often as usable as working drawings.

There are two good ways to learn to make perspective sketches.

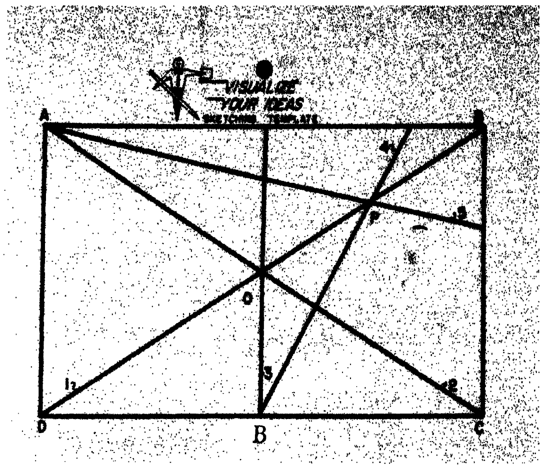
USING A TEMPLATE

A good method of making perspective sketches is to use a plastic template that has guide lines. Fig. 21-2. These lines help you to get the proper slant to your drawings The guide lines on the template form an *angular* perspective. To use this method, place a thin piece of 8½" x 11" paper over the template and proceed as follows. (An airplane is used as an example.) Fig. 21-3.

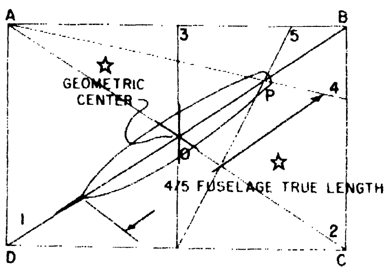
1. The intersection of lines 1, 2, and 3 at point O determines the center of the airplane. All true dimensions are reduced by four fifths for proper foreshortening in a perspective view. The distance between



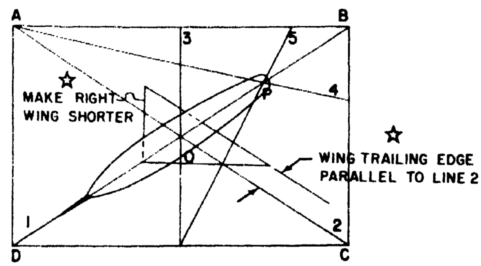
A



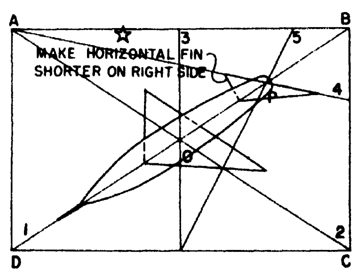
21-2. a. Using a plastic template with thin paper over it as a guide in perspective sketching. b. The lines on the template help you to get the proper perspective. Write to company No. 4 under part A of Appendix for templates.



21-3. Step 1 in sketching an airplane.



21-4. Step 2 in sketching an airplane.



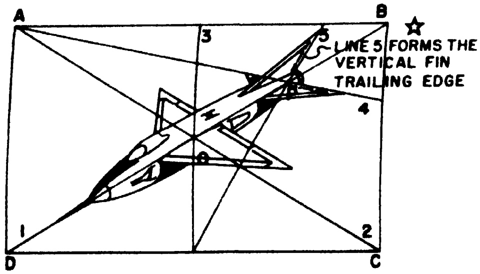
21-5. Step 3 in sketching an airplane.

points O and P is half the length of the fuselage. Place half of the fuselage to the left of point O and the other half to the right of this point on line 1. Fig. 21-3.

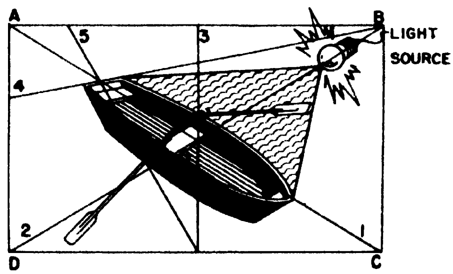
2. Sketch the airplane wings on line 2 with this line as a guide line. Place the left wing on line 2 with the wing attached to the fuselage at point O. Make the right wing slightly shorter than the left wing. The wing trailing edge is parallel to line 2. Fig. 21-4.

3. Sketch the horizontal tail surfaces on line 4, with this line as a guide line. Sketch the right and left horizontal tail surfaces in the same manner as the wings. Remember to make the right one slightly shorter to take care of foreshortening. The horizontal tail surface trailing edge is located on line 4. Fig. 21-5.

4. Sketch the vertical tail surface



21-6. Step 4 in sketching an airplane.



21-7. Using shading to make a perspective sketch more lifelike.

using line 5 as a guide line. Line 5 forms the trailing edge of the vertical tail surface. Notice how the guide lines automatically locate major parts in relation to one another. Add the details to complete the airplane sketch as shown below. Fig. 21-6.

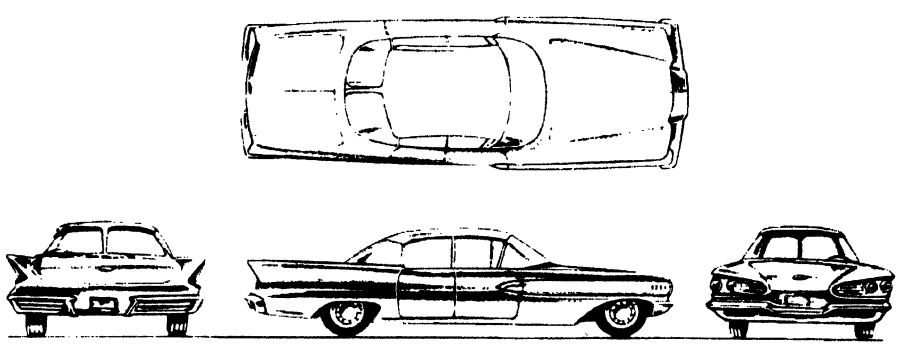
To make a perspective sketch even more realistic it is shaded in to give it a lifelike appearance. Fig. 21-7.

COPYING COMMERCIAL SKETCHES

Another method of learning perspective sketching is to start by tracing perspectives that are used in advertising materials. This is not recommended by your art teacher! But it gives you the "feel" of perspective.

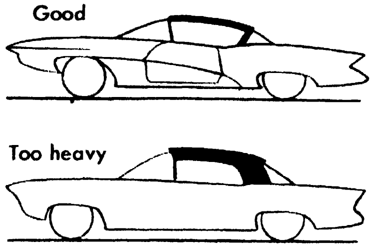
Some suggestions for designing and making a perspective sketch of a car are shown in Fig. 21-8, A to K.

(A) Trace the side view of a present day car from a magazine. Then from memory and observation of the actual car, draw the other views. Sketching four views will help you to visualize the entire car three-dimensionally and give you the feel and proportion of car "form."

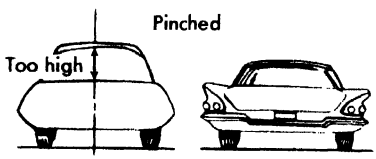


After practicing the above step, try four-view sketches of your own designs.

B You should strive for a light, graceful upper structure in your design.

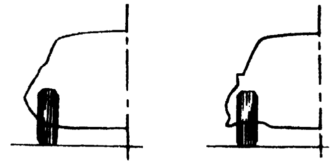


C Rear views

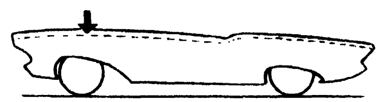


Poor proportion Good proportion

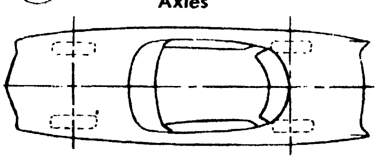
D Design of "section" through car.



The study of new "sections" through the middle of the car will help to stimulate new designs. Remember that pleasing highlight flow along the entire body side is desirable. See drawing below.

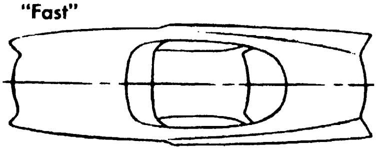


E Axles

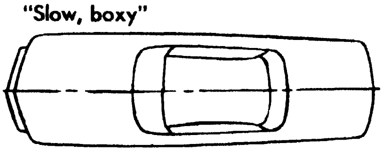


Plan view of your design is important.

"Fast"



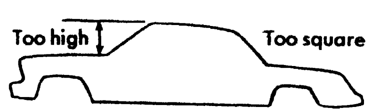
"Slow, boxy"



F Pinched (poor)

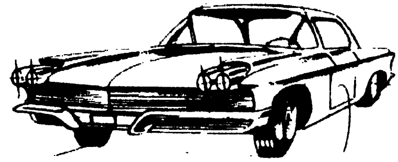
Good "space design"

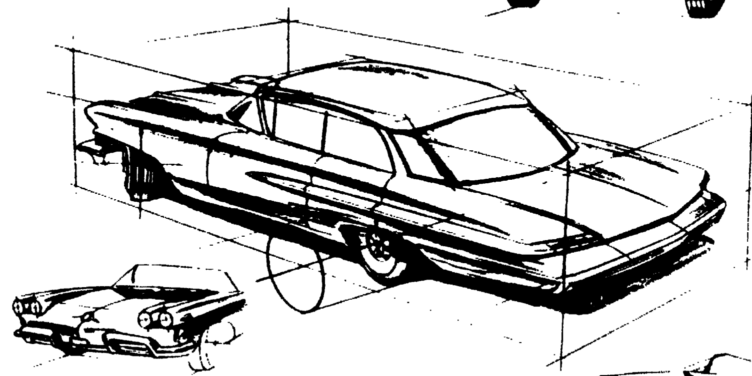
G Side view of upper structure proportions



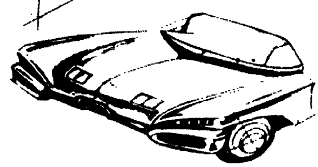
Outline of car

(H) Perspectives help you to feel the form of the car. Note that car can be contained within a simple perspective box.

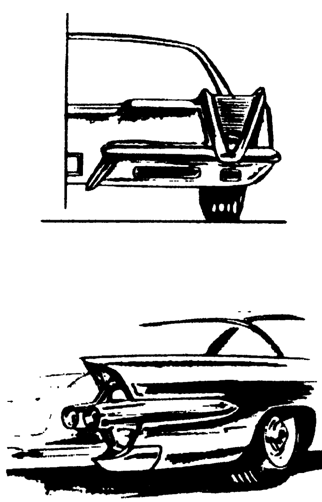




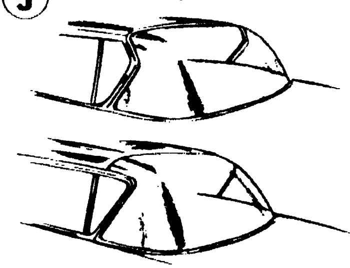
Front end perspectives help you to blend the side of the body with the front end design.



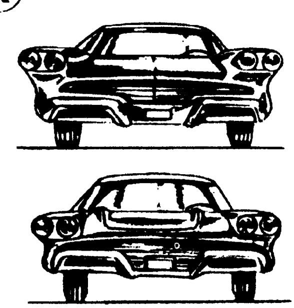
(I) Fender and tail-light theme "doodling"



(J) Study windshields



(K) Study hoods



Section II

22. Designing a Project

The things you make in the shop should be useful and attractive. In other words, they should have *good design*. However, all people do not agree as to what good design is. Design actually is the use of line, form, color, tone and texture to make up the whole of anything. These are found in all objects, but they must be used properly and with understanding or the design is poor.

Most important is *usefulness*. The object must do its job well or it is poor design. It may be something practical like home plate in baseball, or merely an ornament like a wall plaque. If it is useful as well as good to look at, it is well designed. Recognizing good design is something you must learn to do. It doesn't "come naturally." The best way to learn about design is to study objects that have good design.

22-1. Some novelty items that you might use for awhile and then discard or redesign.

WHAT KIND OF PROJECTS CAN WE MAKE IN THE SHOP?

From the standpoint of design there are three kinds:

1. Trinkets, gadgets, and novelties. Fig. 22-1. As you learn more and more about design you will see that these do not always have the best design. Perhaps at some time you have made a wooden cutting board or a letter holder in the shape of an animal. Maybe the project was something you designed yourself. You liked it. You may have found later that the project was not too well designed and you discarded it or revised it. As you work in the shop you will continue to learn more about design. The more you know about it the

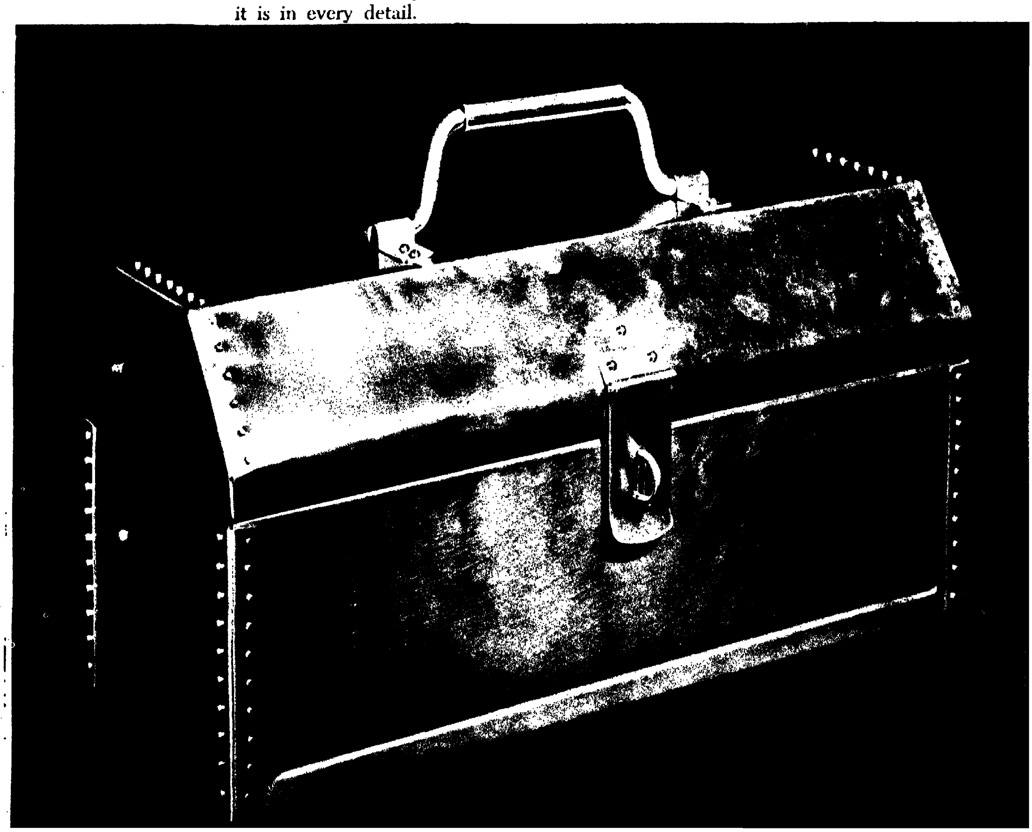
22-2. This tent must be well designed if it is to do its job. It may not be the most glamorous one in the world, but it is good design if it is useful, functional, and durable.

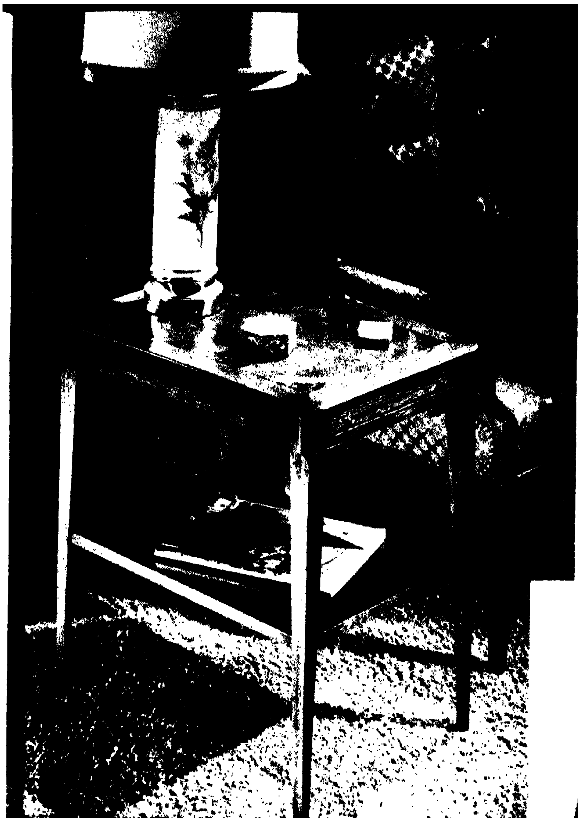
better you will be at selecting well designed objects or designing them.

2. Practical items. Many objects must be a certain size and shape if they are to be of any value. Fig. 22-2. A metal frame for a fishing net must be a certain shape. An ice scraper of plastic will bend too much if made too large. An arm guard for archery should be made the right size to protect your arm and shirt properly. A drill-press vise must hold the material firmly in place. These practical things are well designed if they do their job properly. Fig. 22-3.

3. Artistic items. A piece of furniture should have good design and proper style. Popular styles today can generally be classified as Early American, Traditional, or Mod-

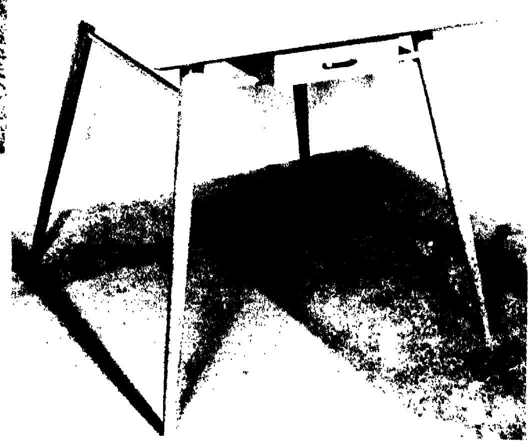
22-3. Another practical item—a tool chest—that is useful and good looking. Careful workmanship is the thing that makes it stand out. Notice how neat it is in every detail.





A

B



C

22-4. All three of these tables are well designed. A. A traditional Chippendale. B. An early American butterfly drop leaf. C. A modern design.

ern. Fig. 22-4. Look at some good books on furniture styles. Too often you see furniture that has no style. The same thing applies to accessories. An art-metal project, for instance, should be a beautiful accessory, not a piece of pounded metal. Also, the things you make should be suited to the materials from which they are made.

WHAT MAKES UP DESIGN

Design is made up of many things:

1. *Lines:* straight, wavy, curved, zigzag, and spiral.

2. *Shapes:* lines make up shapes—squares, rectangles, circles, triangles, free-form shapes. These are flat designs, or two-dimensional. They might be used in a layout for a surface design for leather or metal.

3. *Mass:* shapes make up solids like cubes, rectangles, spheres, rods, bars, and others. Most things we make in metal and wood are three-dimensional. They have mass.

4. *Tone and texture:* materials are of different textures. No two surfaces are exactly alike. Also, you can add texture to things by painting, decorating, carving, tooling, and the like. For example, texture can be added to leather by tooling although leather has a texture all its own.

5. *Color:* all things have some color of their own. Additional color can be added as a surface decoration or by a stain or dye on materials such as leather, wood or plastics. Color combinations are many and varied. The use of color is an important part of design.

WHEN IS AN OBJECT PLEASING IN APPEARANCE?

There are not set rules that make one object pleasing in appearance and another ugly. There are, however, some simple principles of design arrangement that should be followed.

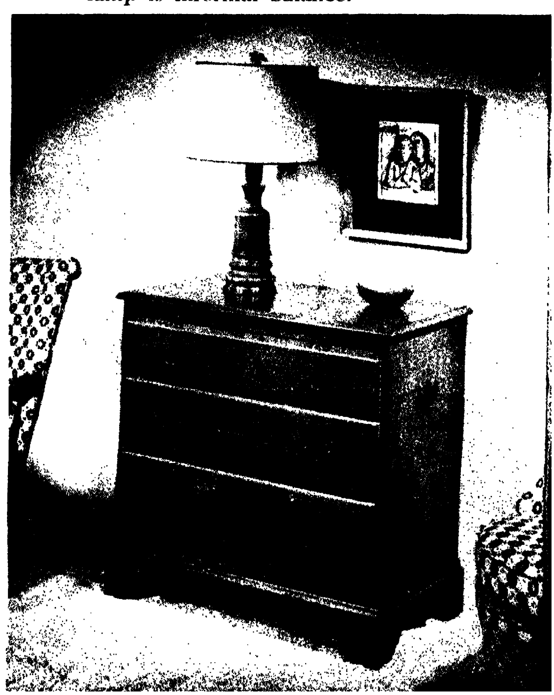
1. *Balance.* This is what makes a thing look stable. Two people of equal size using a teeter totter are an example of perfect balance. Two lamps of the same design are also in balance. This we call formal balance. A teeter totter will also balance if one larger person sits closer to the center and a smaller person is seated farther out at his end. Or you might have a heavy, small area balanced by lighter areas or textures. This we call informal balance. Fig. 22-5.

2. *Proportion.* We say something is "out of proportion" if the parts are the wrong shape or if they don't match each other in size and shape. Fig. 22-6. We learn proportion by looking at nature. Most things, animals and people, are in good proportion. Most dwarfs are not. An example of good proportion is the strong legs on a grand piano. Spindly legs would be bad proportion.

3. *Harmony or unity.* A thing has harmony when its parts blend together. Objects may be made of different materials such as metal, wood, and cane that will still get along well together. Fig. 22-7. Things which must harmonize are colors, shapes, textures, and materials. A house with too many different textures (buff stone, red brick, white wood, blue shutters) lacks harmony.

4. *Rhythm* is present in many things such as the sweeping curved line of a candle holder or in the repeating of lines, shapes, or decoration. Fig. 22-8. Rhythm is the repetition of some shape or pattern or

22-5. This arrangement of picture, tray, and lamp is informal balance.



design. Buildings and homes often repeat the same shape in windows. Cars are decorated with chrome trim. These make rhythmic patterns.

5. *Emphasis.* Emphasis can be obtained in many ways. For example, the main point of interest on a piece of furniture might be a very unusual wood grain or a piece of hardware or a spot of color, a carving or a decoration.

WHAT MUST YOU THINK ABOUT WHEN DESIGNING A PROJECT?

When designing anything you must ask yourself questions like this: What is the thing to be used for? Will it be simple to make? Is it easy to put together? Is it easy to care for? Does it have a pleasing appearance? What is the best way to use the materials at hand?

STEPS IN DESIGNING

Suppose you and your class decide to make a magazine rack. Here are some of the things you will think about first:

1. What is it to be used for? To hold magazines. What sizes are these magazines? Will it be easy to get the magazines in and out? Can the magazines be seen for easy selection?

2. What kind of room is the rack to be used in—a boy's room, living room, playroom? The magazine rack should belong with the other furniture of the room. Is the furniture Traditional, Early American, or Modern? The rack should be in proportion to the other pieces in the room

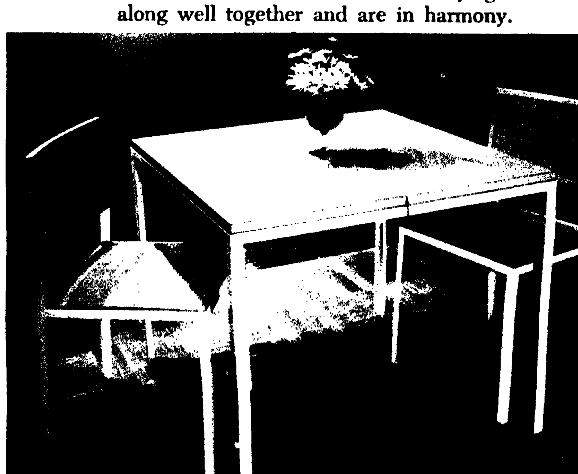
22-6. This chair is just right in proportion to be really comfortable.

also. It shouldn't be too large or too small.

3. What will the rack be made of —wood, metal, plastic, leather, or a combination of these?

4. Make sketches of some of your ideas. Have you applied the rules of good design arrangement? Should

22-7. Many different materials are used in this chair and table set but they get along well together and are in harmony.



you make a two- or three-view drawing of it?

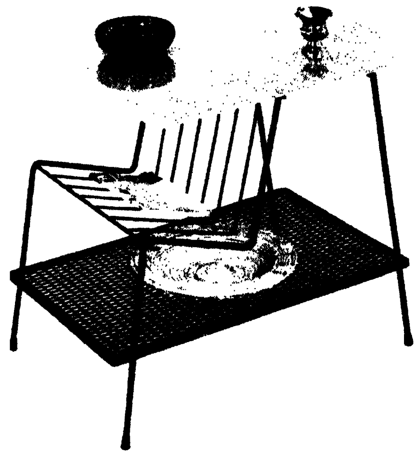
5. How is it to be constructed? Will it be made of wood and assembled with glue, screws and/or nails? Will it be made of metal and riveted together? Will it be made of wrought iron and welded together?

6. How is it to be decorated — painted surface, a design on the surface such as peening or coloring, or finished with filler and stain?

7. How is it going to look when it is finished? Make a perspective sketch of the rack. Check for any mistakes you may have made in the design. Include specifications for the parts of the magazine rack.

8. Should any changes be made? Make any changes necessary in the sizes of parts, materials to be used, and details of construction. Does it look well as designed or does it need some redesigning? Make a small wooden model of the rack.

9. Make a complete set of working drawings and a bill of materials.



22-8. The magazine rack on this table is a good illustration of rhythm

10. Construction. Build the magazine rack after you have made any necessary changes.

11. Checking. Does the magazine rack carry out the principles of good design? Does the rack look well in the room where it is to be used? Does it match the furniture in the room? Is it a good, solid accessory and not just a useless ornament? Most important, does it do its job well—is it functional?

Section II

23. Planning a Project

Project *planning* gets your ideas, tools, and materials together. When you do this you won't waste time during the building of the project. Fig. 23-1. It's really a way of deciding what to do and how to do it. What do you do when you plan a camping trip? Certainly you decide ahead of time where and how you are going, what you'll take along, and how much of everything you'll need.

Just imagine that your family has decided to build a house. What do you think would happen if you'd call the contractor and say, "Order some lumber, nails, and cement. We want a house. *Plan*, you say? Oh, we'll just let the workmen start." What kind of house do you think you'd get?

To be really successful in any kind of shopwork you must observe this motto, "Plan your work; then work your plan."

How do you plan? Here are some helpful ideas:

1. Decide on what project you are going to make. At first your instructor may decide on something he thinks you can build. This first project will help you to get acquainted with tools and materials. Later he may allow you to choose one from several well-designed projects. Still later you and the others in the class may work out a design together. When you can design something on your own you have reached the final step.

What kind of things can you make? Here are a few suggestions.

a. Things you can wear or carry: billfold, ring, tie pin, key case, bracelet or arm band, watch band.

b. Things you can make for your room: wall plaque, lamp, radio shelf, bulletin board.

c. Sports items: ski rack, toboggan, home plate, fishing rod, bow and arrows, tackle box.

d. Games and puzzles: checker board, cribbage board, yo-yo.

e. Hobby items: radio, motor, model plane, tools, stamp album.

f. Animals, birds and pets: bird feeder, dog house, rabbit hutch, bird bath, dog collar, small animal cage.

g. Camping and scouting: reflector oven, roasting sticks, tin cup, metal camping equipment, sheath and knife, pack carrier, camp stool, foot chest.

23-1. This man is checking his plan to see that he has all of the tools and materials ready to start building his project. That's what you should do, too.

h. Things for the home: accessories, furniture, practical things such as cookie sheets, window screens, kitchen implements, tableware.

i. Parents and relatives: gifts.

j. Community projects: street signs, school bicycle rack, toys for Red Cross, refuse boxes.

2. How can you secure a plan? When you have decided on something to make, you can look through books or magazines or visit stores. In some cases your instructor will have project plans from which you can choose.

3. Make a drawing or sketch. It's important to make a drawing or detailed sketch of whatever you plan to build. A drawing should tell you the size of the parts, the shape, the materials, and any other information necessary. All of your work in this course of DRAWING AND PLANNING FOR INDUSTRIAL ARTS should help you to make a view or pictorial drawing. Use a Planning Sheet, as shown in Fig. 23-2.

4. Make a bill of materials. From the drawing you can figure out exactly what materials you need. A bill of materials lists the number of parts, the size of each, the kinds of materials, and the name of each part. Sometimes the cost is also included. Fig. 23-3 shows you how common materials are purchased. You can get more information from your instructor or from books on each subject. This list of materials is most important. If you're building something on your own at home, you'll need the list when you go to the lumber yard, the hardware store, or the supply house. In your shop the list will help you to get the right amounts and kinds of materials.

PLANNING SHEET

Name ________________ Grade ____

____
Name of the Project

________________ ________________
Date Started Date Completed

Bill of Materials:

Number	T	W	L	Name of Part	Material	Unit Cost	Total Cost

Tools and Machines:

Procedure or Steps:

1.
2.
3.
4.
5.
6. Etc.

23-2

HOW MATERIALS ARE PURCHASED

A. Lumber. By the board foot, by the 100 bd. ft. or by the 1000 bd. ft. (M). Some lumber such as molding is sold by the linear foot.
B. Plywood. By the thickness and square foot.
C. Sheet Metal. By the thickness and the sheet or by weight.
D. Metal Shapes (band, flat, rod, square, octagon, and hexagon). By the shape and per foot or by weight.
E. Art Metal. By gauge number, weight per square foot, or by the pound.
F. Leather. By square foot or by hide.
G. Plastics. By the foot or square foot.
H. Electrical Wire. By the foot or by the 100 feet.

23-3

5. What are the steps in making the project? It's not possible to know how to build something until you've had some experience. It will be easier

to plan after you've worked with tools and materials for awhile. Every project is different but all of them are built about like this:

a. Measure and cut out the material needed.

b. Make a layout.

c. Shape the materials by cutting, forming, bending, etc.

d. Decorate the surface. You could burn a design in wood, etch metal with chemicals, tool a design in leather, or metal, for example.

e. Assemble the project. In wood you will use glue, nails and or screws and joints. In metal you will rivet, solder, weld, or make seams. In plastics the parts are cemented or screwed together. In leather you cement, sew, or lace the seams.

f. Finish the project. In wood you may stain and apply lacquer, shellac, or varnish. You may paint or lacquer wood or metal, dye plastics, and apply wax to leather.

6. What tools and machines will you use? After you have decided what steps you need to follow, you also must decide what tools and machines you will use. Go over each step and ask yourself the following questions: "How can I do this? What tools will I need? Can I use a machine for this step?" Write out a list of these tools and machines.

PROBLEMS—SECTION II

Section II—QUESTIONS AND TOPICS FOR DISCUSSION

e need shop drawings or sketches?

2. What kind of paper is used to make the shop drawing or sketch?

3. What is an isometric shop drawing?

4. Why is freehand sketching quite hard to do? Explain.

5. Tell how the following are drawn freehand: (a) a straight line, (b) a vertical or slant line, (c) a square or rectangle, (d) a triangle, and (e) a circle or arc.

6. Explain how you would proceed to draw a freehand shop sketch.

7. Why is it a good idea to draw a perspective sketch of a project before building it?

8. Can perspective sketches be used for construction? Explain.

9. Explain the use of the plastic template for perspective sketching.

10. How can commercial sketches help you in improving your drawing?

11. Name and describe the things that make up design.

12. What are the principles of design? Tell a little about each.

13. What are the many different things you should think about when designing a project?

14. W

before starting to build it?

15. Why does the teacher usually decide what you are to build at first?

16. When can you design a project yourself?

17. Where can you get project plans?

18. Why is it necessary to have a drawing of the project?

19. What is included in a bill of mate-

20. Name the general steps in building a project.

21. Why is it a good idea to plan the tools, materials and machines needed?

Section II—SELF-CHECKING WHAT YOU HAVE LEARNED

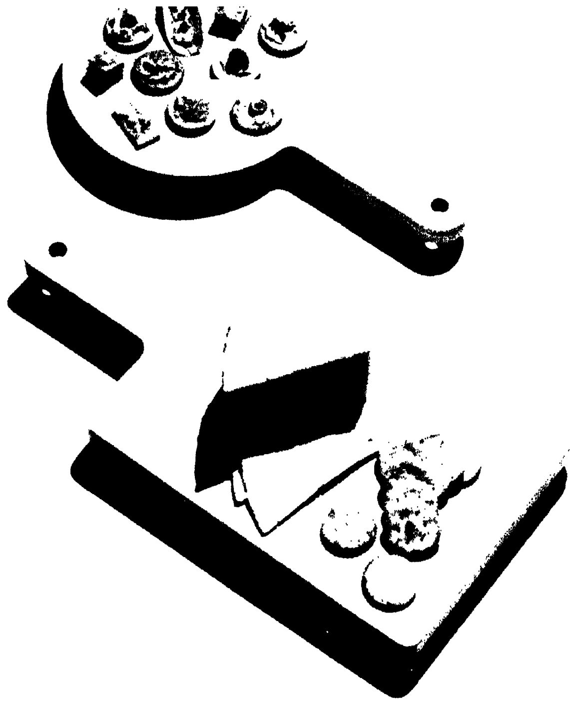
PART I. True-False

1. A freehand sketch is made in order to put your ideas on paper.

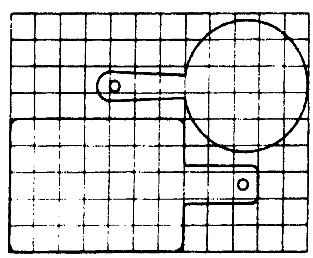
2. Shop sketches of view drawings are made on squared paper.
3. Shop sketches are complicated drawings that include a lot of detail.
4. Hard drawing pencils (3 or 4H) are used in making freehand sketches.
5. When sketching a square, the first step is to sketch vertical and horizontal construction lines.
6. A straight line should be sketched in one stroke of the pencil.
7. The sketches you will use in shop work are mostly view drawings.
8. Take great pains to stop at the points where the lines join when sketching construction lines.
9. All construction lines should be erased from a freehand sketch.
10. A perspective sketch with dimensions can be used for construction.
11. Sketches of commercial products found in magazines are usually perspective sketches.
12. You are born with the ability to judge good design.
13. Rhythm can be described as a repetition of shape or design.
14. Project planning means deciding what to do and how to do it.
15. Your first project should always be one you have designed yourself.

PART II. Fill In

1. A very simple drawing on squared paper that is used in the shop for building a project is called a________.
2. A good measuring or judging tool to use in sketching is your________.
3. The most difficult shape to sketch freehand is the________.
4. An object cannot have good design unless it is________.
5. Straight, wavy, curved, zigzag and spirals are examples of________.
6. Squares, rectangles, circles and triangles are kinds of________.
7. To make a half size drawing on ⅛" squared paper, each square must represent



II-A-2A

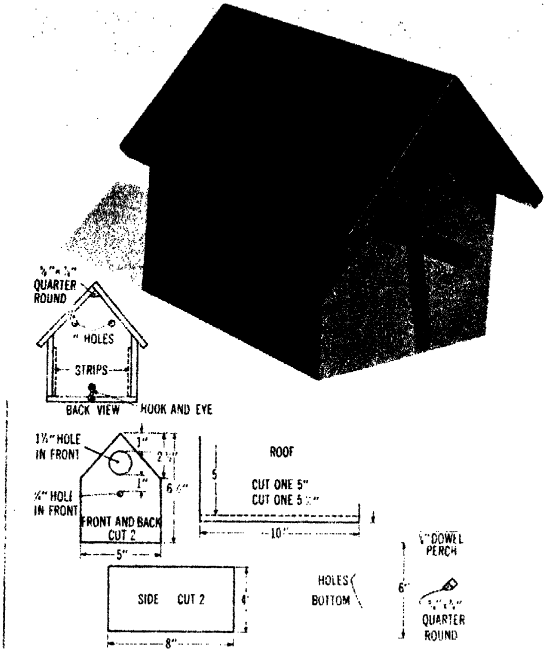


2" x 2" squares

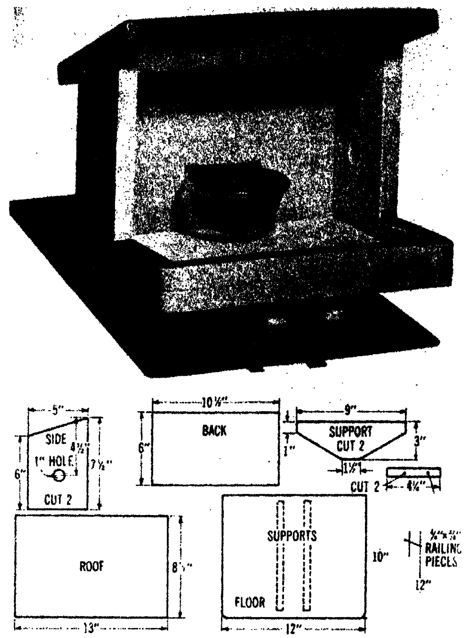
II-A-2B

____ inch.

8. The first phonograph was built from a________.
9. Isometric cross section paper has lines drawn at angles of________degrees.
10. The tools and materials needed for freehand sketching include________, ________, and________.
11. To figure out exactly what materials you need, make a________.
12. Four good sources for project plans are________, ________, ________, and your own instructor.



II-A-3



II-A-4

Section II—APPLYING WHAT YOU HAVE LEARNED:

ACTIVITIES, THINGS TO DO, PROBLEMS, EXPERIENCES

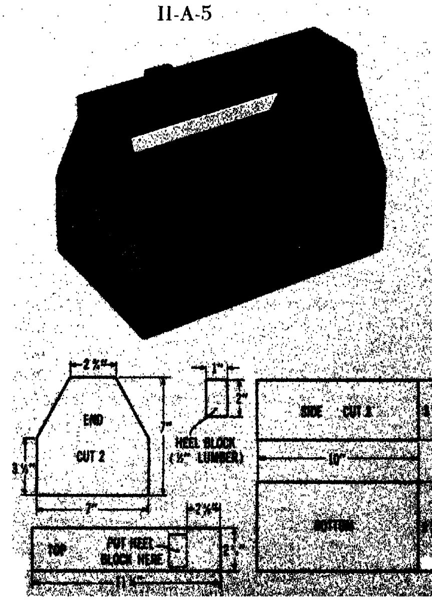
A. Complete the following activities on cross-section or isometric paper. Use only a rule, a pencil, an eraser, and a simple pencil compass.

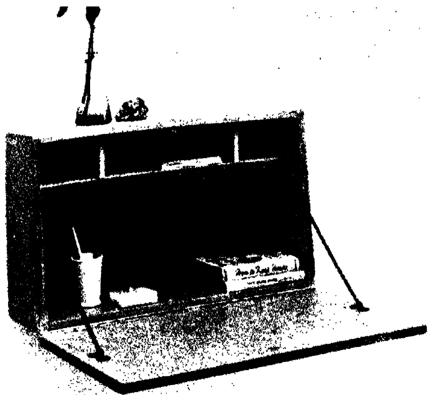
1. Make a shop sketch of the yard sign shown in Fig. 19-3.
2. Fig. II-A-2 shows two simple serving trays. Make a shop sketch for one of these.
3. Complete a full size shop drawing for the parts of the birdhouse. All pieces are of ½" lumber. Fig. II-A-3.
4. Specify ¾" lumber to make this bird feeder. Complete a full size shop drawing of each part. Fig. II-A-4.
5. Make an isometric shop sketch of the shoe shine box. Fig. II-A-5. ¾" lumber.
6. Make a shop sketch of the cookie cutter in Fig. I-C-1.
7. Complete a shop sketch of any of the problems shown in Section I.
8. Make a shop sketch of one of the items shown in Fig. II-A-8.

B. Make a freehand sketch of the following problems:

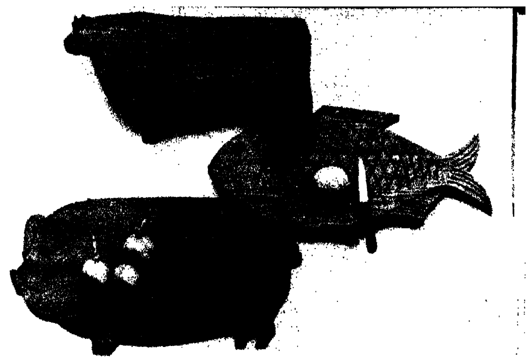
1. Sketch the squares and circles shown in Figs. 4-3 to 4-7. The squares and circles may first be drawn to size—2". Make each line parallel.
2. Sketch the solid punch in Fig. II-B-2.
3. Sketch the knife rack in Fig. 20-13.

II-A-5

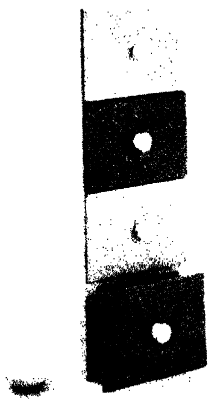




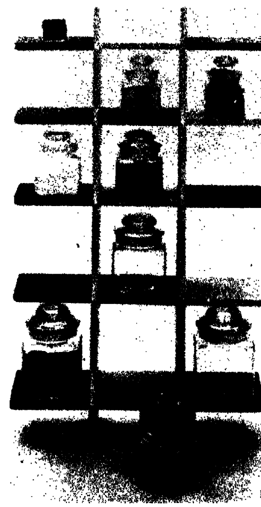
McCall's 1[illegible]



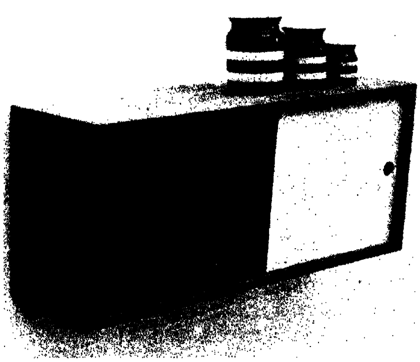
McCall's 112 [illegible]



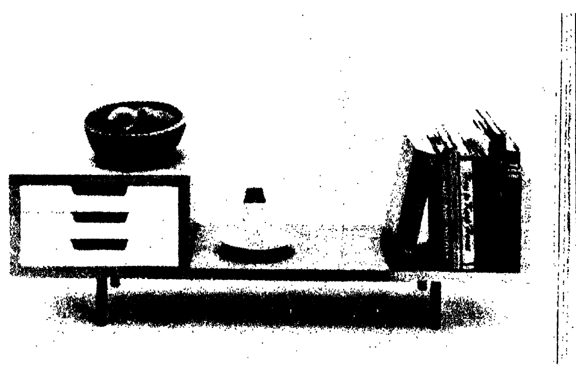
McCall's 105 W



McCall's 102 W

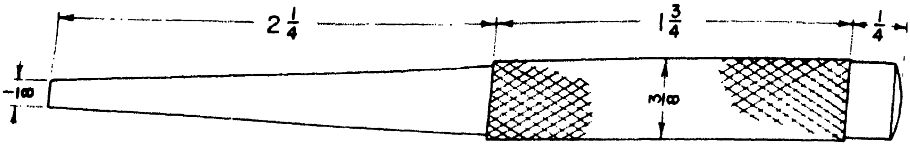


McCall's 104 W

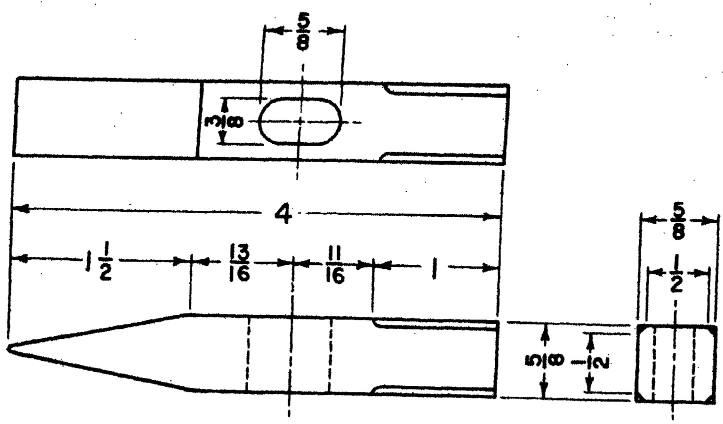


McCall's 109 W

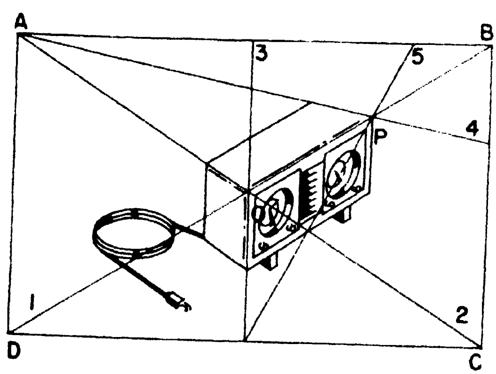
II-A-8



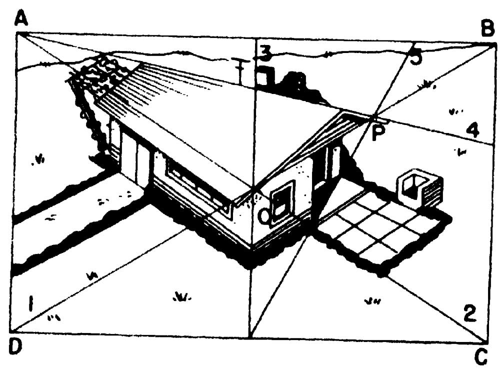
II-B-2



II-B-11



II-C-1



II-C-2

4. Sketch and dimension a sheet-metal box such as is shown in Fig. 10-3.

5. Make a three-view sketch of the oilstone shown in Fig. 12-20.

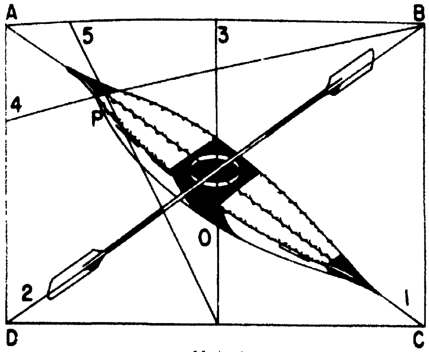
6. Make an isometric sketch of the lamp in Fig. 20-18.

7. Sketch the mallet head shown in Fig. 17-15.

8. Make a pictorial sketch of some of the tools shown in Fig. 28-1 and Fig. 29-1.

9. Make a cabinet sketch of the common cuts of wood in Fig. 28-3.

10. Select one of the simple tools shown in Fig. 28-1 and make a working sketch including all dimensions and notes. Use the actual tool to do the measuring.



II-C-3

11. Make an isometric sketch of the riveting hammer in Fig. II-B-11.

12. Make a sketch of any of the problems in Section I.

C. Make a perspective sketch of any of the following:

1. Sketch a table radio such as is shown in Fig. II-C-1.

2. Sketch a house like the one shown in Fig. II-C-2.

3. Sketch a kayak like the one shown in Fig. II-C-3.

4. Place a thin piece of paper over the photograph of the car in Fig. II-C-4. Trace it and shade it in. Note the problems in shading to achieve a good effect. Poor shading is worse than none at all.

5. Trace any items found in a magazine. Then make perspective sketches.

D. Do the following activities in design:

1. For many things you see and use it is important to have good ratio (proportion) between height and length. One such ratio worked out by mathematics is called the *golden oblong*. In Fig. II-D-1A you see a series of these oblongs. The one at the right with a ratio of 5 to 8 is said to be the most attractive. Use the oblong as shown in Fig. II-D-1B and make a sketch of one of the following: picture frame, small chest, or bulletin board.

2. Often you may wish to increase or decrease the rectangle proportioned 5 to 8. Draw a rectangle, ABCD, 5" x 8". Draw a line from A through C to any length. Mark off along line AX a distance of AE equal to 4". This rectangle will be in good proportion. Now design a rectangular note box 1" deep with the long side 5" long. Fig. II-D-2.

3. Fig. II-D-3 shows the golden rectangle divided into three areas. Notice that C is most interesting. To divide the rectangle into three parts, proceed as follows: Draw a line from A to B. Fig. II-D-3D. Place a triangle with the base along this diagonal line. Draw lines at right angles to this base so it passes through points C and D. At these points draw a vertical line. Using this method, divide the inside shelf of this hanging desk; Fig. II-D-3F. Assume that the front is 15" x 24".

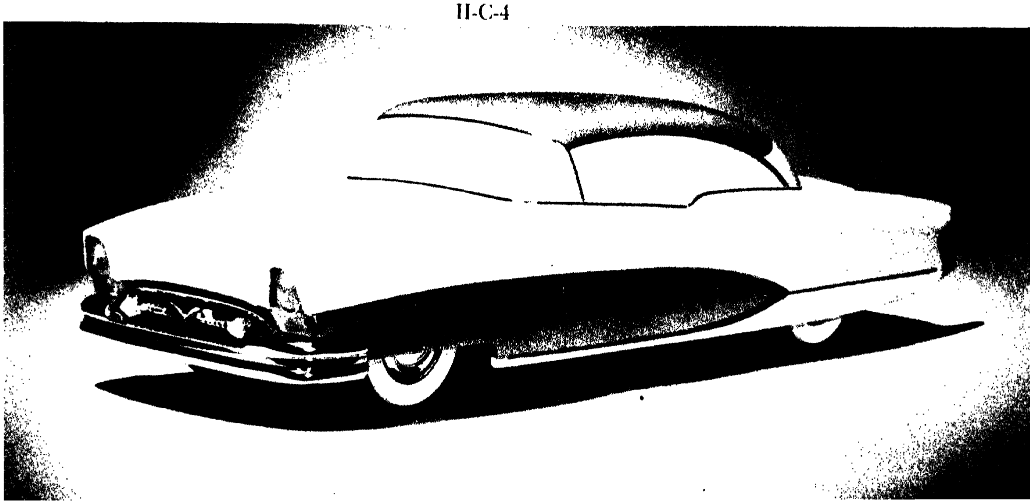
4. Design a simple wood tray, using the proportion shown in Fig. II-D-1A.

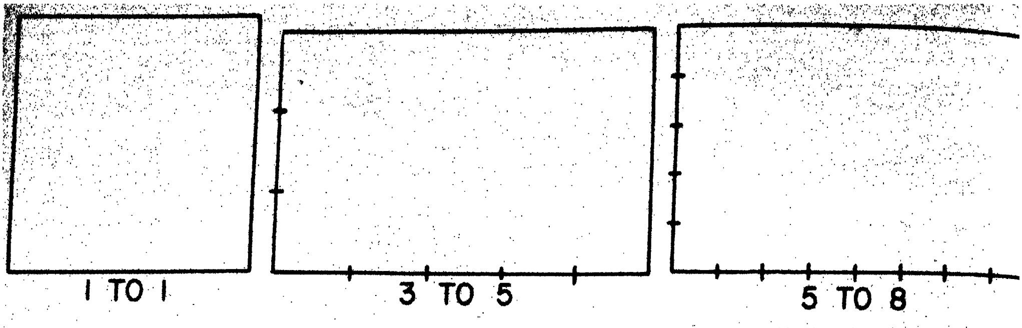
5. Using Fig. II-D-5A and Fig. II-D-5B as guides, design a wall shelf of the desired size. Enlarge the rectangle to any size. Make the shelves to fit the ends.

6. Using the suggestion shown in Fig. II-D-6, design a metal magazine rack. Measure the sizes of the magazines to be used in it. Perhaps you might add another smaller tray for small magazines.

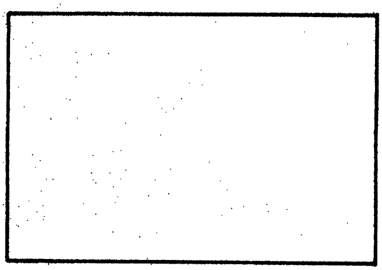
7. Using the suggestion shown in Fig.

II-C-4

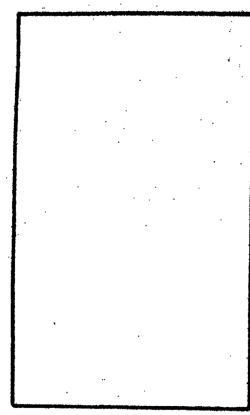


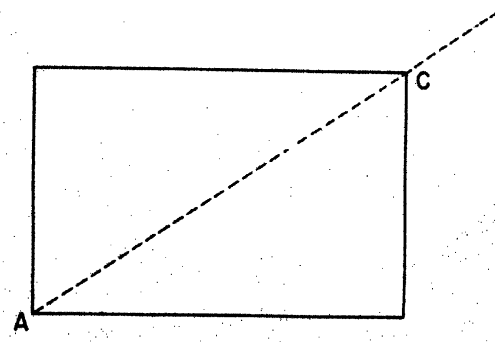


II-D-1A

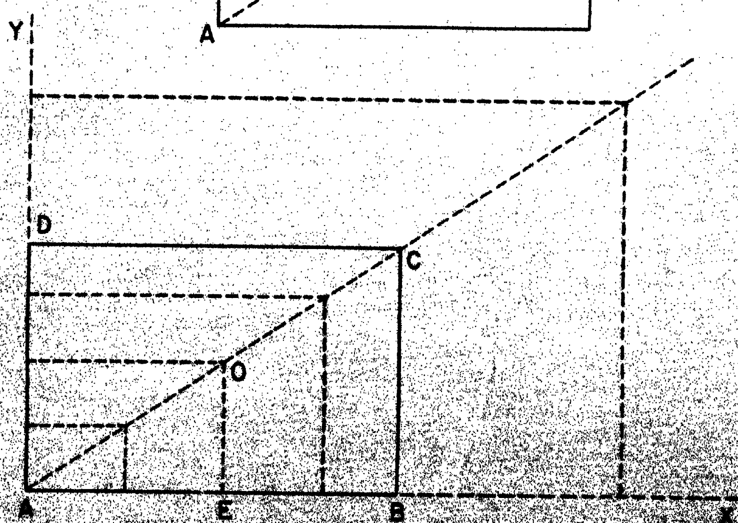


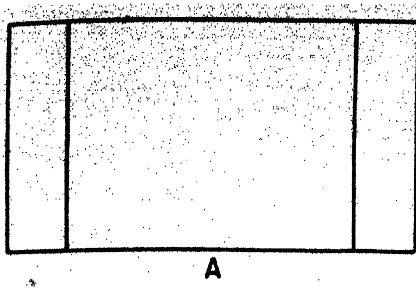
II-D-1B



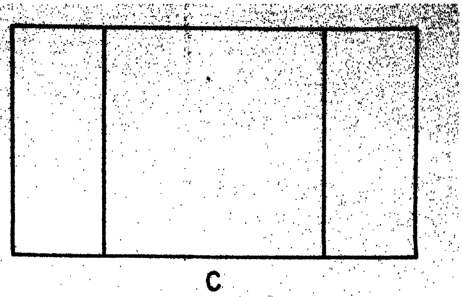


II-D-2

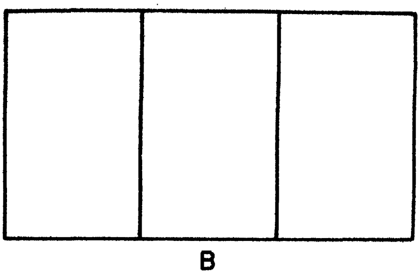




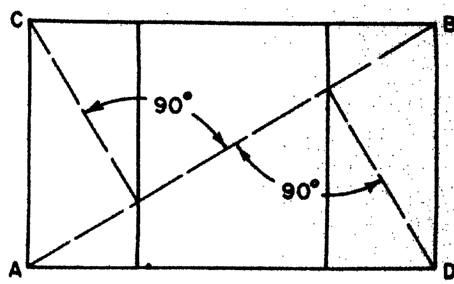
II-D-3A



II-D-3C

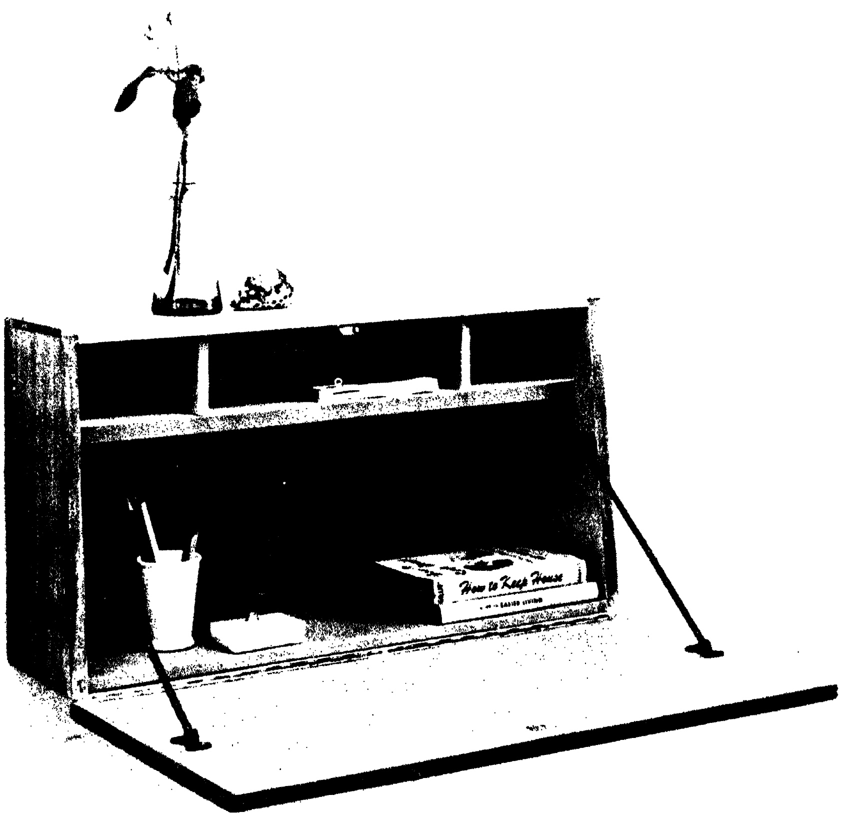


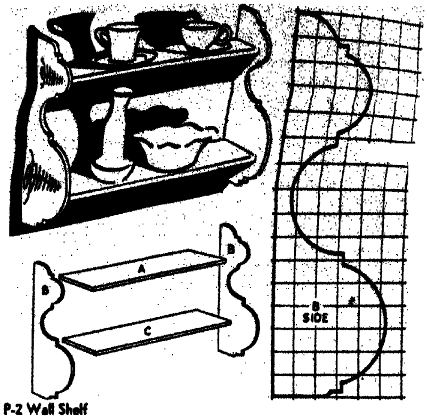
II-D-3B



II-D-3D

II-D-3F





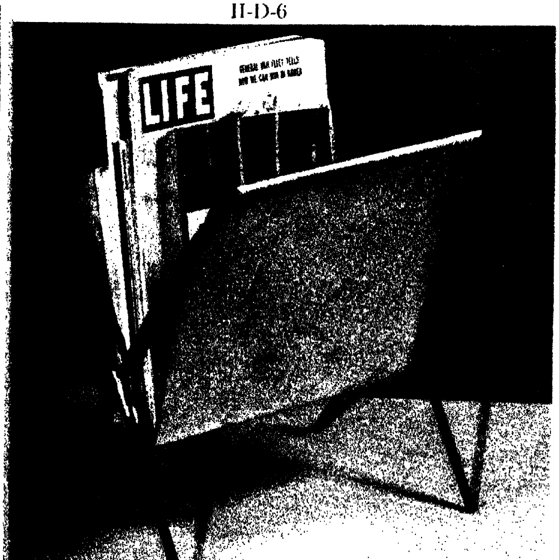
II-D-5B

II-D 5A

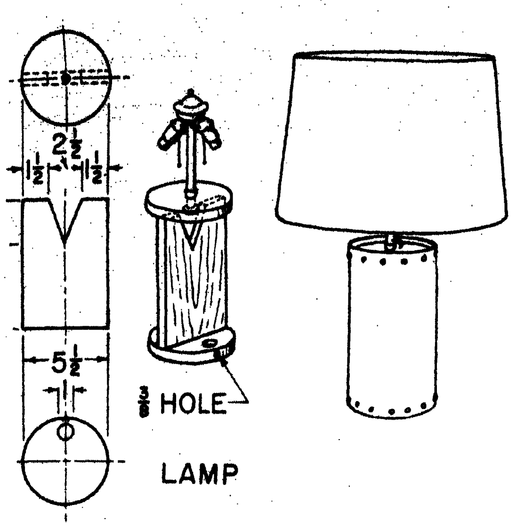
II-D-7, design a metal candle holder. Th base of the candle is ⅞" in diameter. Th center holder should be about twice th height of the side holders. Use ⅛" x ¾ metal for the parts. Make a layout o squared paper.

8. Using the suggestions shown in Fig

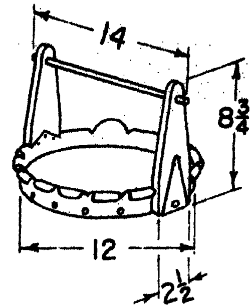
II-D-6



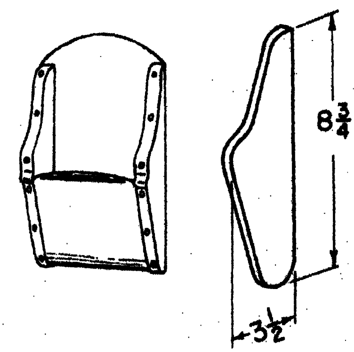
II-D-7



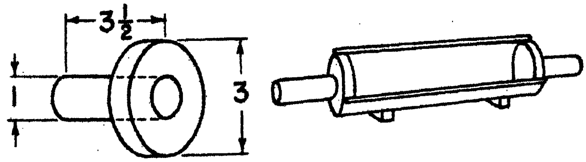
LAMP



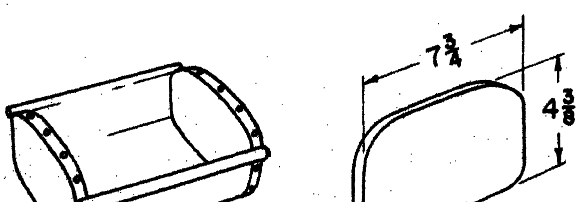
SERVING TRAY



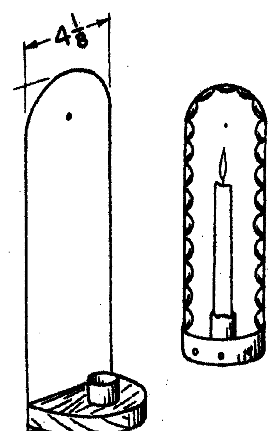
LETTER HOLDER



ROLLING PIN TRAY

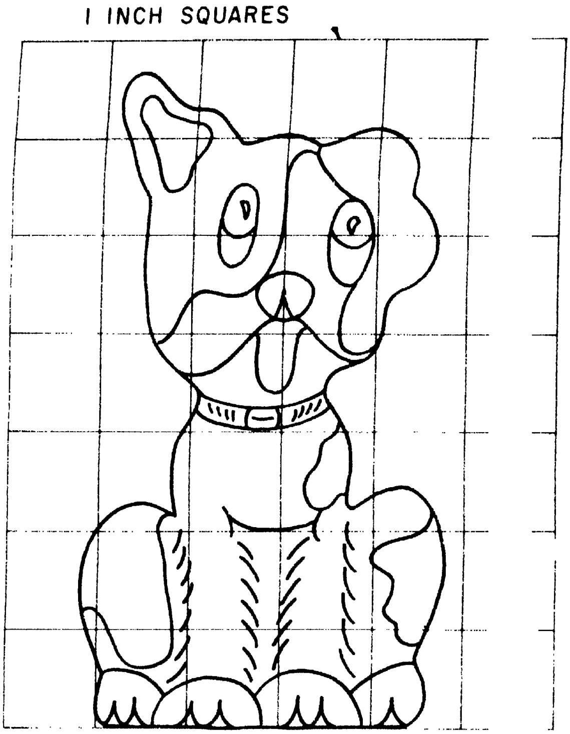


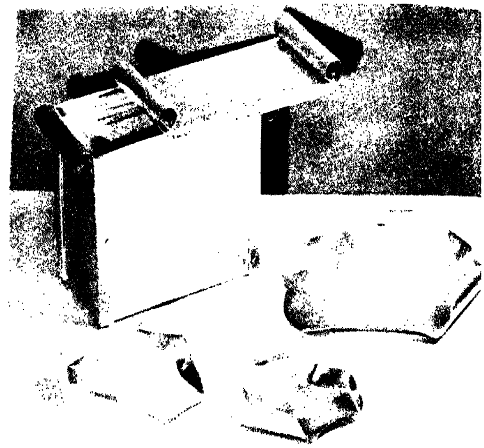
TRAY



SCONCE

II-D-8

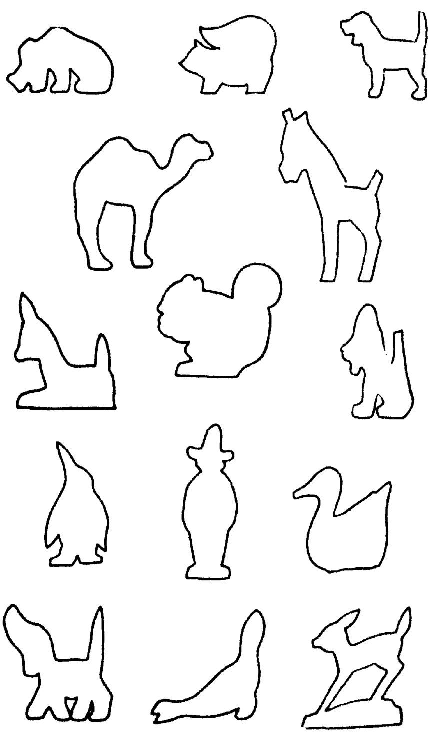




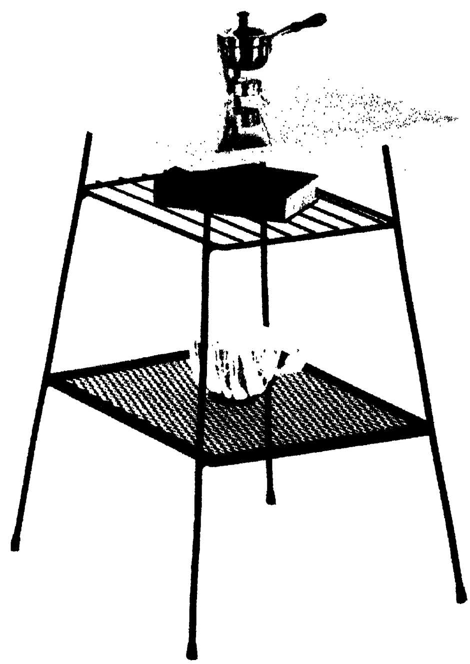
II-D-11

II-D-8, design any one of these projects. Make a detail drawing for each part. Show the size and kind of material you will use for each part.

9. Using the figure suggested in Fig. II-D-9, design a simple project such as a tie rack, pin-up lamp, door stop, or book-end. Is this an artistic design or a "trinket"?

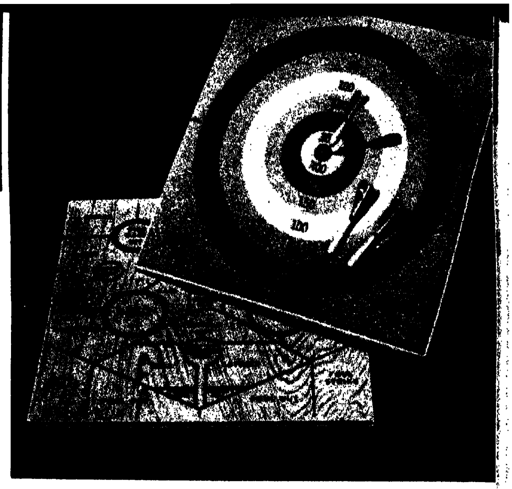


II-D-12

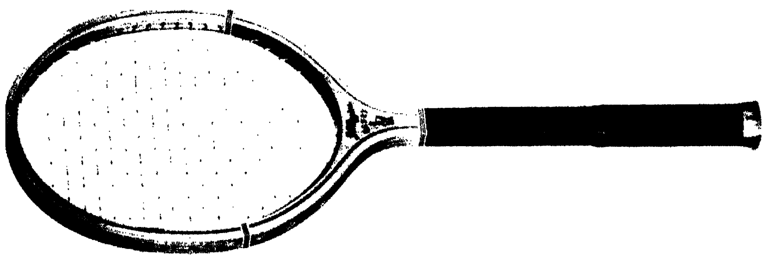


II-D-13

II-D-14



II-D-15



II-D-16

10. Design a billfold. Include parts of the billfold and a surface decoration for the outside surface.

11. Design a letter file and tray as shown in Fig. II-D-11. The file should hold standard letter size paper.

12. Enlarge one of these designs to use as a decoration on an art metal or leather project. Fig. II-D-12.

13. Design a wood and metal end table that is 18" x 18" x 28" high. Use Fig. II-D-13 as a guide.

14. Make the drawings for a ring toss game as in Fig. II-D-14. The cross pieces that form the base are 9½" long. The stakes are 6" high.

15. Make a layout to some suitable scale of a dartboard. It is 18" x 18" square. Fig. II-D-15.

16. Design a racket press for a tennis racket. Measure the size of a tennis racket and then design a pair of wooden frames that will hold the racket flat and true. Fig. II-D-16.

E. Complete the following activities in project planning:

1. Make a bill of materials for one project shown in Fig. II-D-8.

2. Complete a project planning sheet for any of the projects you plan to build. Letter in all the information.

Section III: DRAFTING PRACTICE

HERE is a *preview* of the things you will learn in *drafting practice* . . . what you should know and be able to do after you have studied the units in this section:

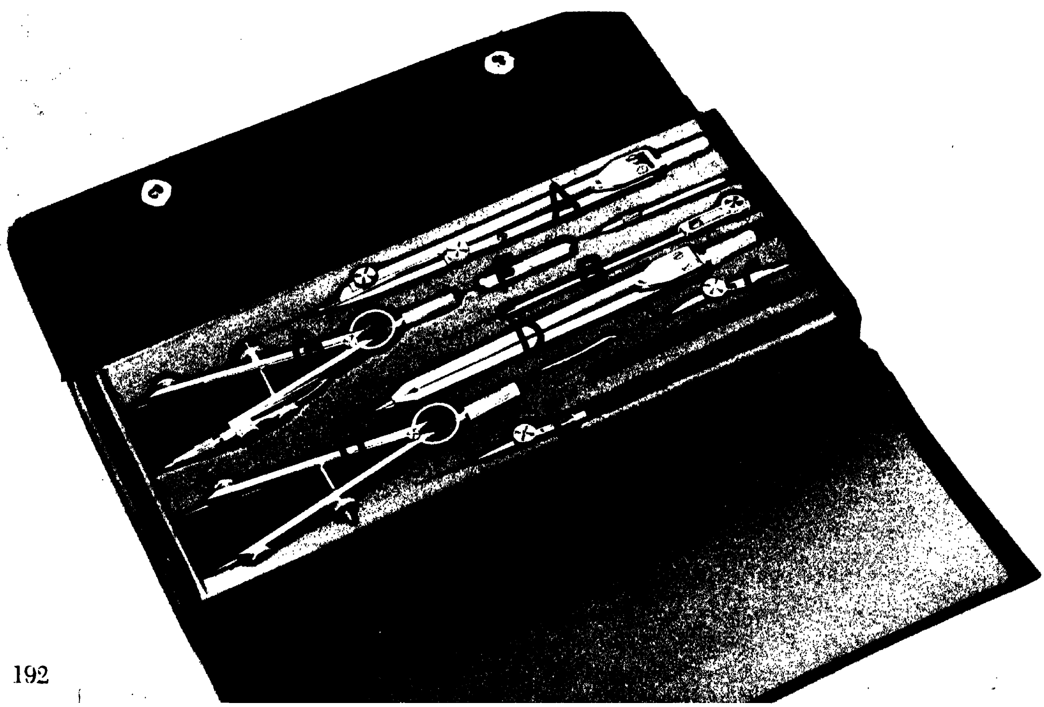
1. Drafting sets and what they include.
2. The kinds of compasses.
3. How to use a compass.
4. The architect's scale.
5. The engineer's scale.
6. Using the architect's scale to draw objects to different scales.
7. Special equipment for drafting.
8. What it means to draw something "in section".
9. Kinds of sectional views.
10. The use of symbols.
11. Helpful things to remember when drawing sections.
12. Auxiliary views and why they are needed.
13. Kinds of auxiliary views.
14. How to make an auxiliary view.
15. How to make many useful geometric constructions such as bisecting a line, dividing a line into several equal parts, bisecting an angle, and drawing an arc at a square corner.

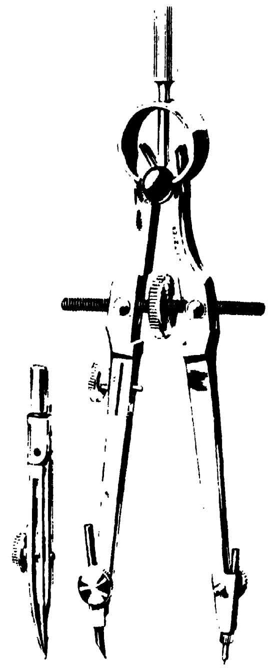
Section III

24. Drawing Instruments and Equipment

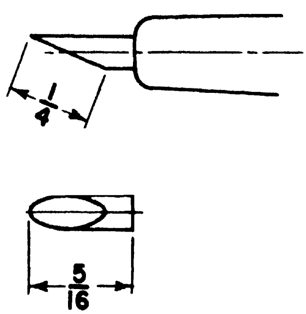
You have already learned that good drawings can be made with very simple tools. These elementary tools are found in all shops and most homes. But for draftsmen, engineers, architects, designers, and others who plan a career in drafting, instrument sets and other equipment are available. If you intend to follow one of these professions, it is a good idea to purchase a set of these instruments. You will have an opportunity to use them now or in a more advanced course. These instruments are fine precision tools and, if given the proper care, will last a lifetime. They are made to help produce more exact drawings. Remember, however, that the appearance and usefulness of the drawing *depends chiefly on the person making the drawing and not on the tools.* The best looking drawing made can be worthless if it is full of mistakes.

24-1. A set of drafting instruments: A. Compass. B. Lengthening bar. C. Pen point. D. Dividers. E. Ruling pen. F. Box of leads. G. Small bow compass. H. Small bow dividers.





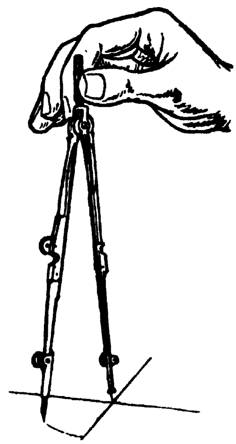
24-2. A spring-joint compass, sometimes called a large bow, or center wheel, compass.



24-3. Correct way of sharpening the point of a compass lead.

DRAWING SETS

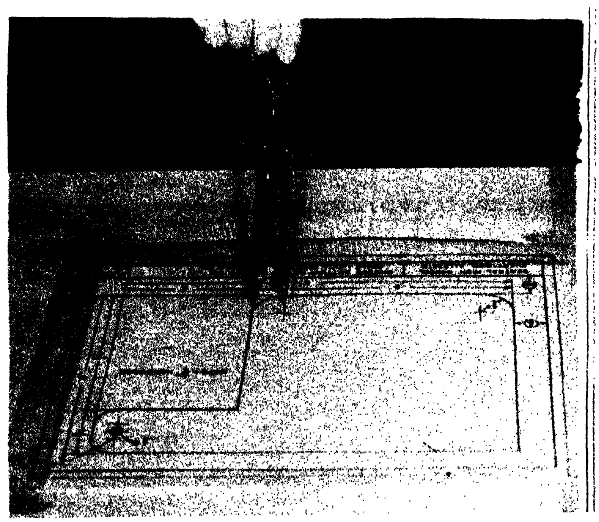
A set of instruments for drawing is usually purchased in a velvet-

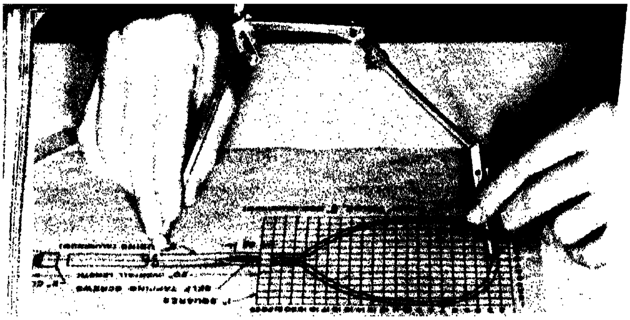


24-4. Using a compass to draw a circle.

lined leather case. Fig. 24-1. These matched sets range from the very simple with a few tools to very complete ones with several different sizes in each tool. A typical student drafting set would include: (a) a 6″ compass with lengthening bar and interchangeable pen and pencil point, (b) a 6″ dividers, (c) a small bow compass with pen and pencil point, (d) a small bow dividers, (e) a ruling pen, (f) a box of leads, and (g) a small screw driver.

24-5. Using a compass to draw an arc.





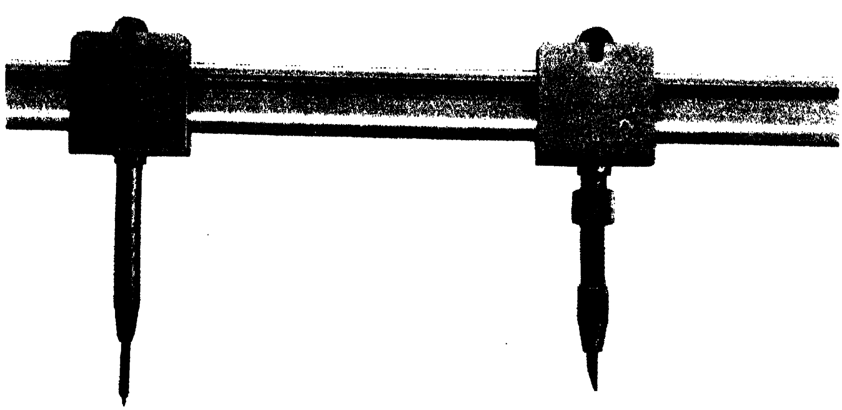
24-6. Drawing a large arc with a lengthening bar on the compass.

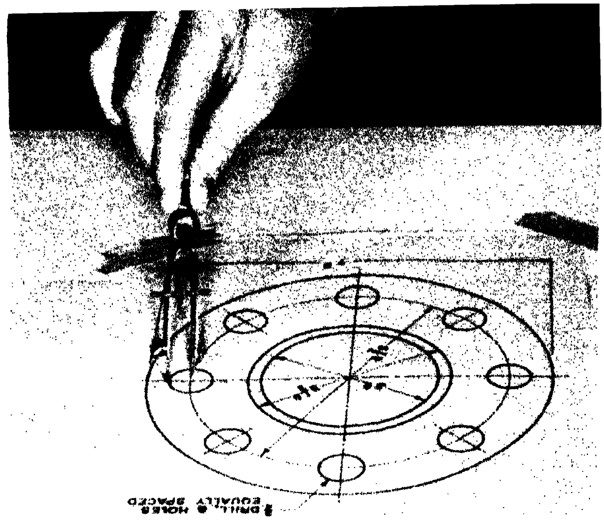
COMPASSES

A compass is used to draw circles and arcs. There are two types—the *friction-joint* and the *spring-joint*. The friction-joint, or adjustable leg, must be pulled open and pushed closed by hand. The joint should be tight enough to open and close under moderate pressure. This can be adjusted with a small screw at the joint. If the compass works too hard, it is *difficult to adjust it accurately. If it* works too loosely, the legs may spread when a circle or arc is being made. The spring-joint compass, sometimes called a large bow, or center wheel, has a knurled nut attached to a screw thread between the legs that is turned to open and close the compass. Fig. 24-2.

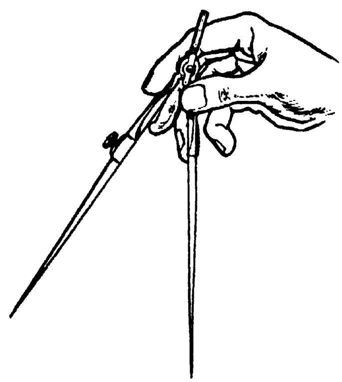
Using the compass. The compass has one metal point on one leg. In the other leg a pencil point or pen point can be inserted. The pencil point is used for most drawings. The pencil used in the compass should be as soft as, or one grade softer than, the pencil used for straight line work. Usually a 2H pencil is used. The pencil is sharpened on a fine file to a chisel point about ¼″ long. Fig. 24-3. The outside of the bevel should be rounded slightly to make the point smaller. Insert the pencil point with the taper side out. The pencil should be about shorter than the metal point.

24-7. Beam compass.





24-8. Using a small bow compass.



24-9. A dividers.

To adjust a compass, place a rule or scale over a blank piece of paper. Place the point next to the zero mark and set the other leg to the correct radius. Use the compass as described in Unit 5, Section I. Figs. 24-4 and 24-5.

For circles larger than 6″ in diameter, the friction-type compass has a lengthening bar. Bend the leg so the point and the pencil point are perpendicular to the paper for all circles 5½″ in diameter or larger. Hold the compass with both hands as the circle is drawn. Fig. 24-6.

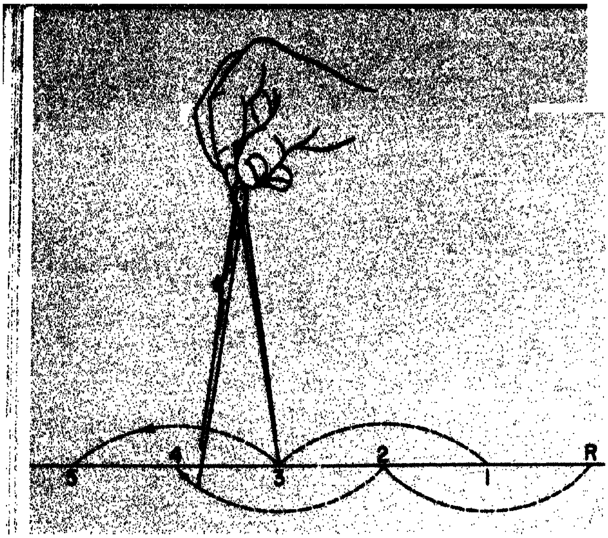
In drawing sets with the spring-type large bow compass, a *beam compass* is also available for drawing large circles and arcs. This is a long metal bar with two adjustable parts. One part contains the metal point and the other the pencil or pen. Fig. 24-7. These can be adjusted to any length.

Bow Compass. This is a smaller spring-type compass used for drawing circles less than 2½″ in diameter. Fig. 24-8.

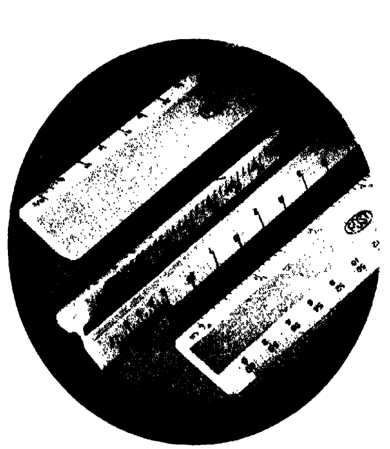
Dividers. Dividers are used to lay off equal distances on a straight or curved line, to transfer measurements, and to divide a line into equal parts. Fig. 24-9. It is similar to a compass except that it has two metal points. To lay off equal distances, adjust the dividers to the correct length. Start at one point and step off the first space. Then rotate the dividers a half turn to lay off the others. Fig. 24-10. To transfer measurements, set the dividers on the first measurement and then move the dividers to the new position. To divide a line into equal parts, adjust the dividers by trial and error and space off the line. Readjust until the desired number of spaces is secured.

ARCHITECT'S SCALE

Scales are used to draw objects full size and either larger or smaller than full size. The architect's scale is available in either a flat shape or the triangular shape of boxwood. Fig. 24-11.

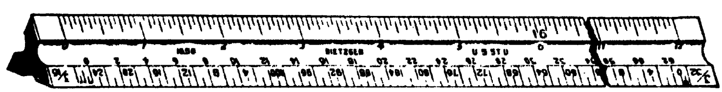


24-10. Using a dividers to lay off equal spaces. Notice how the points are rotated, one to another.

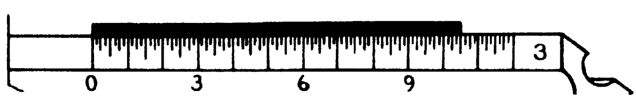


24-11. Three common kinds of scales. The most common type used in industry is the flat scale with two bevels opposed, as shown by the scale to the left. The next most popular is the flat scale with two bevels on the same side, as shown by the scale at the right. In schools, the most popular is the triangular shape.

You must learn to use the scale well, since it is the basic measuring instrument for drawing. Notice that the architect's scale is made longer than



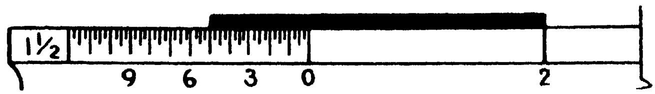
24-12. An architect's scale.



24-13. This drawing of the scale, 3" equals 1', shows a measurement of 10½". Can you read it?

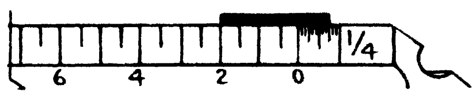
12" so that the ends of the rule and the scales will not be damaged in use. Fig. 24-12. One edge of the scale is a rule with inches divided into sixteenths. This is stamped "16" at one end. If you wish to draw an object *full size* or *half size* this rule must be used. For example, if you are making a drawing half size (6" = 1'), every one of the smallest divisions on the rule represent ⅛" (instead of 1/16") and each inch mark is 2".

If the drawing must be made smaller than half size, this tool has other scales on it you can use. Re-



24-14. This drawing of the scale, 1½″ equals 1′, shows a reading of 17″, or 1 foot plus 5 inches.

member in using any scale that you must think in terms of full-size dimensions, since they are always given that way on the completed drawing. For example, if you wish to make an object one fourth full size (3″=1′), turn to the scale which has "3" stamped on the end. Notice that from zero to the end stamped "3", there are many small divisions. This distance represents 12″, or one foot. There are 12 larger divisions, each representing an inch. Every third inch mark is stamped 3, 6, and 9. Fig. 24-13. The smallest division that can be read directly on this scale is ⅛″. From zero to the other end there are long open divisions, each representing 12″, or one foot. If you wish to lay off a measurement of 19″ on this scale, start at the large division mark stamped "1" to the left of the zero mark. Then go to the right of the zero to the largest division past 6, which is 7″. This would then be 19″. Once you get used to this scale it will be as easy to use as an ordinary rule. See Fig. 3-13.



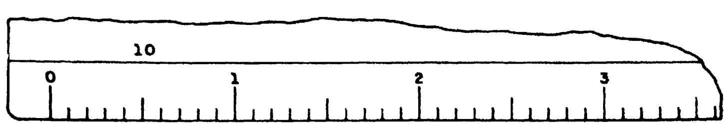
24-15. This shows a part of the scale ¼″ equals 1′, showing a measurement of 33″, or 2 feet and 9 inches.

On the opposite end of the tool is a scale stamped "1½″", or one eighth size (1½″ = 1′). The smallest readable division on this scale is ¼″. Fig. 24-14. Other scales that are used frequently include:

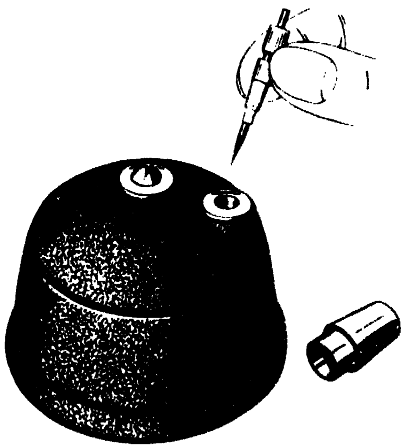
1″ = 1′ (one twelfth size) 1/12.
¾″ = 1′ (one sixteenth size) 1/16.
½″ = 1′ (one twenty-fourth size) 1/24.
⅜″ = 1′ (one thirty-second size) 1/32.
¼″ = 1′ (one forty-eighth size) 1/48.
3/16″ = 1′ (one sixty-fourth size) 1/64.
⅛″ = 1′ (one ninety-sixth size) 1/96.

For drawings of rooms, buildings, and house plans, a scale of ¼″ = 1′, or *quarter scale*, is often used. Remember, this is different from quarter *size*, or 3″ = 1′. Fig. 24-15.

Scales can also be used to make



24-16. A part of the engineer's scale. Notice the inches are divided into 10 equal parts.



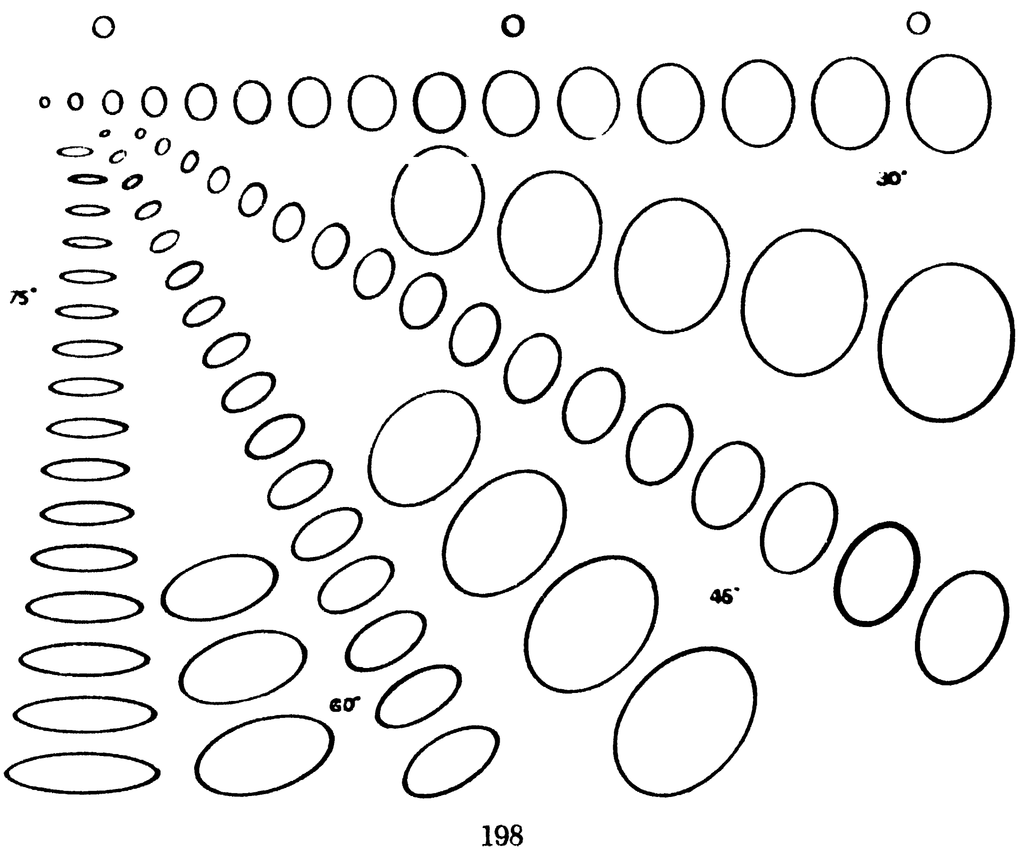
24-17. A pencil pointer used to sharpen the pencil lead after the wood has been removed on a draftsman's pencil sharpener.

drawings that are larger than full size. Suppose you wish to make the object one and one half times full size. Use the scale stamped "1½." Then each division can represent 1″. To find a measurement of 4½″, start at the large division to the right of the zero mark stamped "4" and go to the left of the zero mark to the line stamped "6".

CIVIL ENGINEER'S SCALE

There are several other kinds of scales that can be used in drafting. One that is good for drawing machine parts that are dimensioned in decimals is called the engineer's scale. This has scale graduations of 10, 20,

24-18. One type of plastic template. Templates are available for all work.



30, 40, 50, and 60 parts to the inch. If you were making a full-size drawing of a machine part you would use the scale marked 10. Fig. 24-16. On this scale the distance between 0 and 1 is one full inch. This distance is divided into 10 equal parts (instead of 16 as on an ordinary rule), or each part represents .100 of an inch. Then, if the measurement is 3.250 (3¼"), you will mark off 3 full inches and 2½ divisions beyond the 3" mark. If the drawing is half size, the scale with 20 parts to the inch, or 10 parts to the half inch, should be used. On this scale the distance between 0 and 1 is ½" and this distance is divided into 10 equal parts. The other scales are similar.

This scale is also used by people who draw maps (civil engineers and draftsmen in map making). The units on the scale may be used to represent feet, rods, or miles.

DRAFTSMAN'S PENCIL SHARPENER AND POINTER

A pencil sharpener used by draftsmen removes the wood around the lead the correct distance but leaves the lead unsharpened. A pencil pointer, Fig. 24-17, can be used to sharpen the point to a cone shape and keep it that way. The point is inserted in the hole and the pencil rotated.

TEMPLATES

Templates are plastic devices made with different shaped cutouts. Fig. 24-18. These can be obtained with a great variety of shapes. One, for example, may have holes of different sizes. Another may have the symbols used in electricity; still another the symbols used in chemistry. These are a great help to people who are drawing in a particular field. You may find all types in any complete catalog on drawing equipment.

DRAFTING MACHINE

Many draftsmen use a drafting machine. This eliminates the need for a T square, triangle, and protractor. There are draftsmen who prefer a *straightedge*, which takes the place of the T square. It operates by a system of pulleys and a cord, to keep it at right angles to the edge of the paper at all times. Fig. 24-20.

MECHANICAL PENCIL

A mechanical pencil is one in which lead is held in a slip chuck or the lead is liquid.

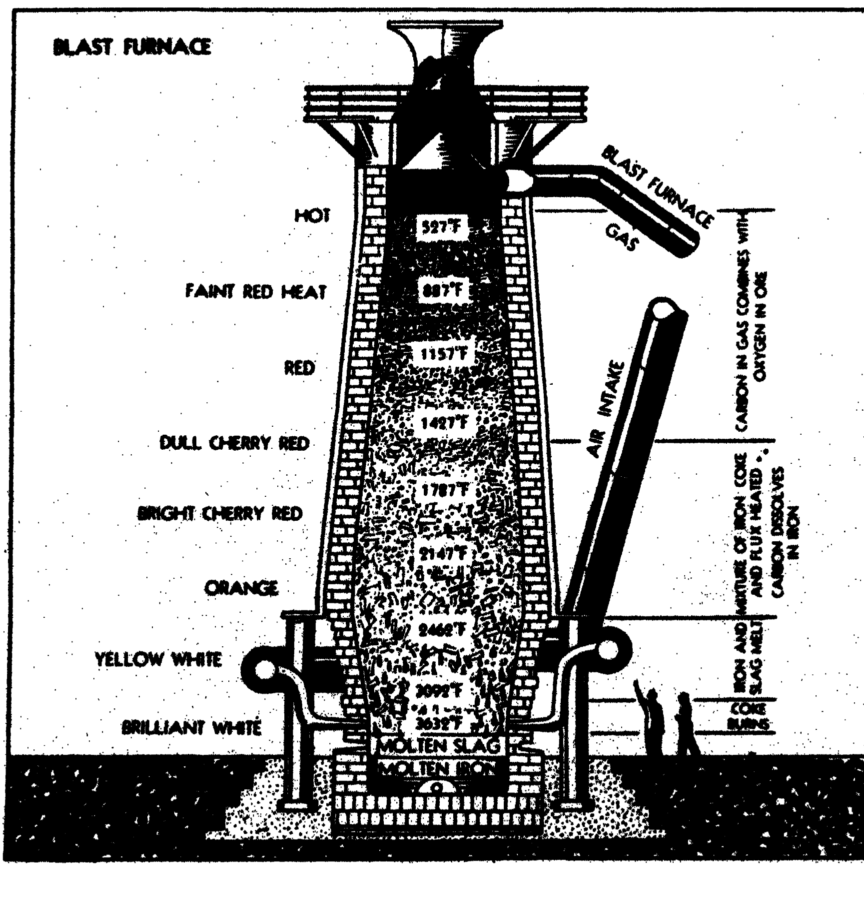
24-19. The draftsman is using a straightedge. See how easily he can move this up and down with a cord and pulley arrangement. Notice also that he is using a mechanical pencil.

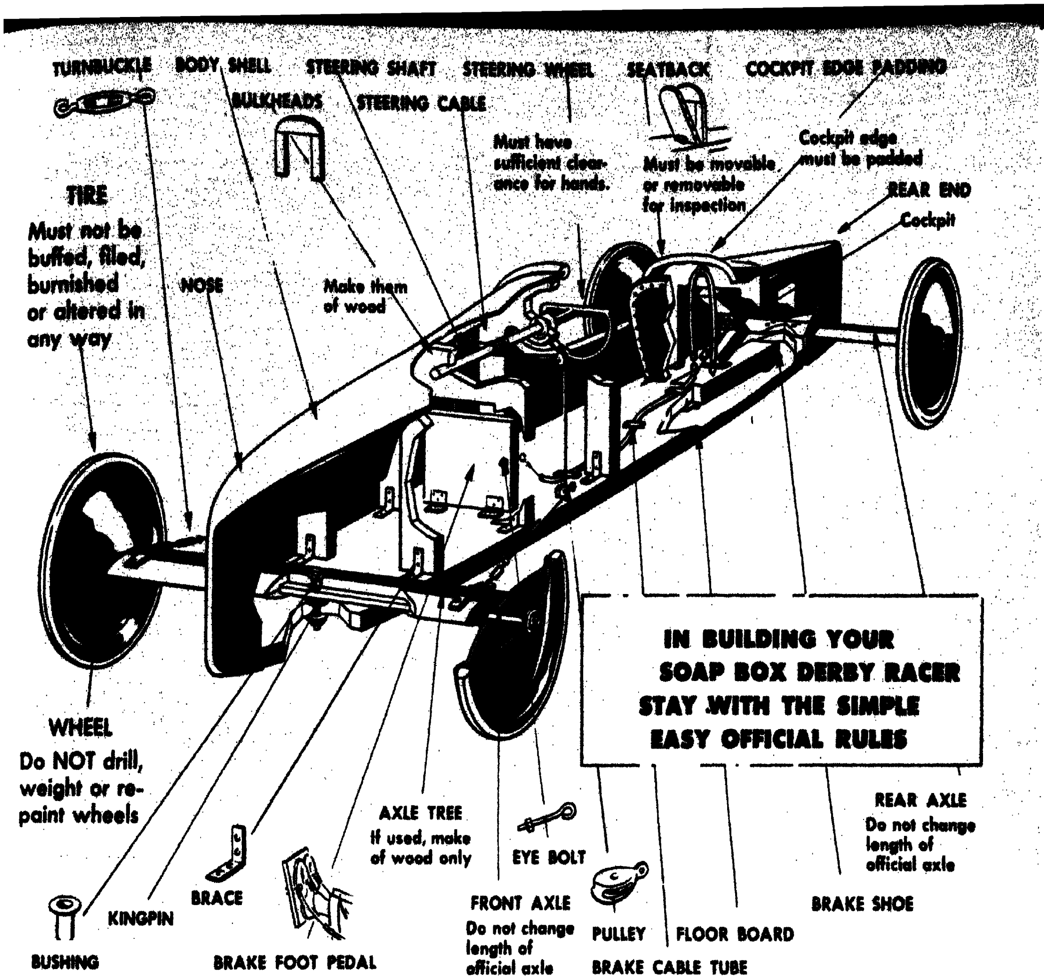
Section III

25. Making a Sectional View

Have you ever been to a fair or exhibit at which machinery and electrical equipment was displayed? Sometimes at these exhibits parts

25-1. This cutaway of a blast furnace shows how it operates.





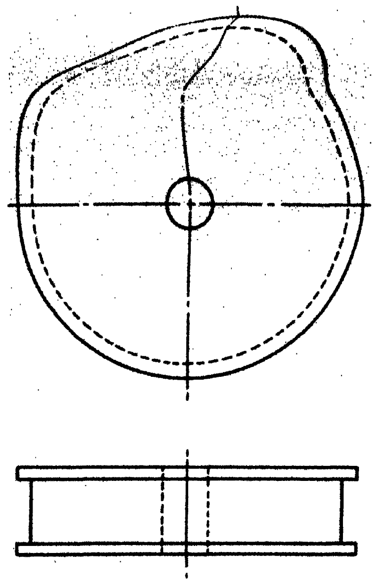
25-2. The cutaway of the soap box derby racer, showing the parts clearly.

have been cut away so that you can see the inside of the object, to find what it is made of and how it works. Fig. 25-1. Here is a cutaway section showing the inside of a soap box derby racer. Fig. 25-2. Imagine how difficult it would be to show all of these parts with hidden or invisible lines.

If you want to show how the inside of something looks in drawing, you can make a sectional view, or "section." Fig. 25-3. This is done by imagining that a part has been cut away as an apple would be cut with a knife. Fig. 25-4. This kind of view is a great help to those who read the drawing. It makes it simpler and points out important details.

MAKING A FULL SECTION

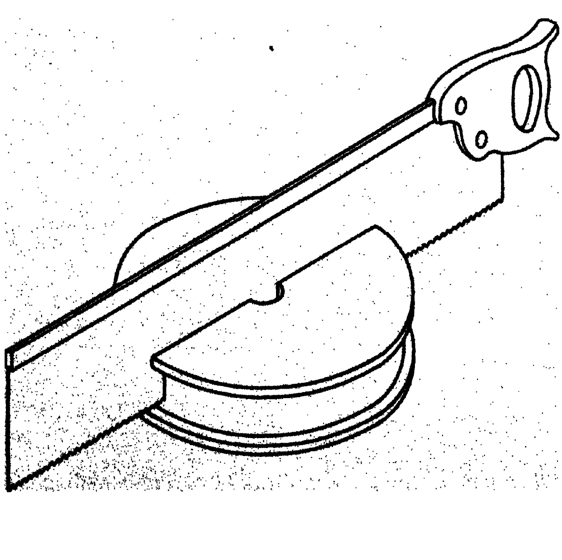
Sections are used with working drawings. Often the front view is shown in section and the side or top view shows where it has been cut. When the front half is cut away it is called a *full section*. Fig. 25-5. On the other view a *cutting plane line*

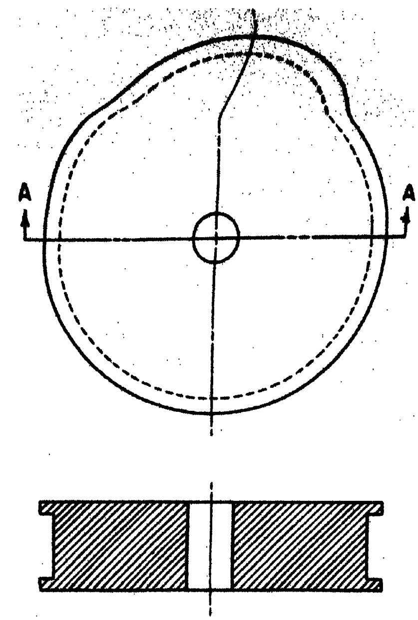


25-3. A standard two-view drawing of a fishing-line spool.

shows where the object has been cut. This line is made up of one long dash (usually ½" to ¾" long) and two short dashes (about 1/16" to 1/8"). Fig. 25-6. Arrows are drawn at the ends of this line to show the direction in

25-4. Cutting the spool. Of course, in drawing, this is done only in imagination. This would make a full-section view.



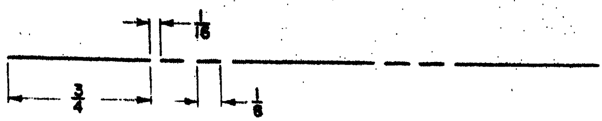


25-5. A full-section view of the fishing-line spool. Notice the arrows and the cutting-plane line on the top view. It shows the direction in which you are looking at the front view. The note "Section A-A" is placed under the section.

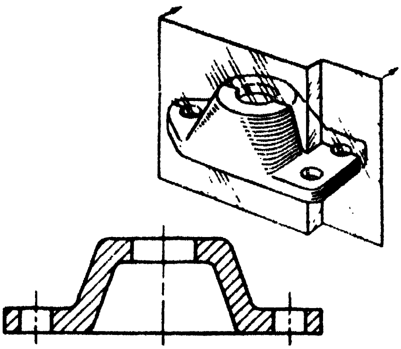
which you are viewing the cut surface. Letters such as A-A are placed at the ends of these arrows. Under the section view the note "Section A-A" is lettered. This is done so that on more complicated drawings the second can be B-B, the third C-C, etc.

In some cases the cutting plane line is offset instead of straight to show better the details in section. Fig. 25-7.

On the section view all areas that are *cut* are covered with *section lines* or *crosshatching*. These are thin



25-6. Cutting-plane line.

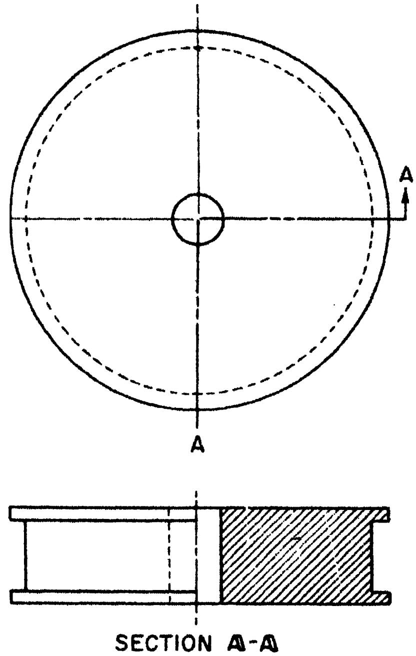


25-7. The cutting plane line may be offset to show certain details better, as is done here with a machine part.

parallel lines at 45 degrees, spaced about $\frac{1}{32}''$ to $\frac{1}{8}''$ apart. Hidden lines are not drawn on the sectional view unless needed for complete description.

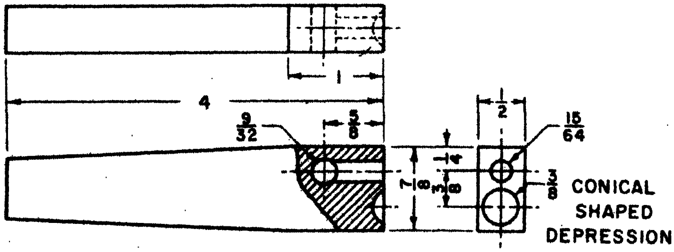
OTHER SECTIONAL VIEWS

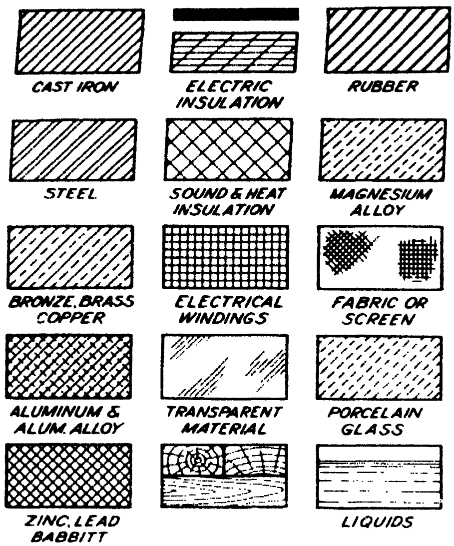
When only half the front section is cut away it is called a *half section.*



25-8. A half section. Hidden lines are shown on the unsectioned side *only* if required for clearness. Here the hidden line was added so that you can easily see the hole.

25-9. A broken out section.





25-10. Symbols that can be used instead of crosshatching or section lining on assembly drawings.

Fig. 25-8. This is used when you wish to show what the outside and inside look like on the same view. Usually invisible lines are not shown on the outside portion of the view. When a part is torn or broken away it is called a *broken out section*. This is particularly useful when showing certain details on a drawing. Notice, for example, how well this shows the shape of the holes on a rivet set. Fig. 25-9.

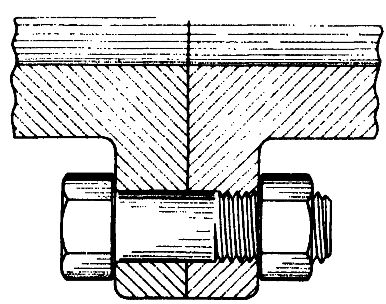
Oftentimes a section will be *revolved* to show the cross-section shape of the object, such as the crowbar shown in Fig. 26-6. Another that may be used is the *removed* or *detail section*. This is similar to a revolved section. A cutting plane line is drawn in a certain location and the shape of that area shown in a detail or removed section to one side of the object. A good example of this is the drawing of a bicycle handlebar. Fig. III-18.

SYMBOLS FOR MATERIALS

Instead of using the crosshatching or section lining, symbols have been developed to identify various kinds of materials. In Fig. 26-6 the symbol on the revolved section indicates that the material is steel. While these symbols do show the kind of material, the information is not specific enough. A note must be added to give more definite specifications for the material. Fig. 25-10.

POINTS TO REMEMBER

1. Use section lining or crosshatching for most drawings.
2. If the section view shows two or more parts, draw section lines at different angles and in different directions to identify the parts. On two parts the lines should be at right angles. Fig. 25-11. Always draw the lines in the same direction on the part as it appears in the drawing.



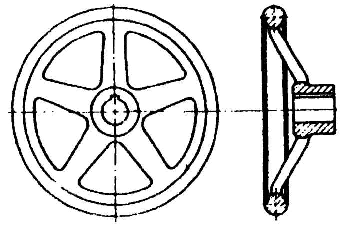
25-11. The crosshatching clearly shows that there are two different parts here. Notice that the machine bolt and nut are not sectioned.

3. Never section bolts, nuts, rivets, and other fasteners. Fig. 25-11.

4. Sections that are too thin for crosshatching (sheet metal and others) can be shown solid.

5. On simple symmetrical objects, the cutting-plane line, letters, and arrows need not be used. The center line can serve as the cutting-plane line.

6. When sectioning objects that are irregular, such as the spokes of this hand wheel, Fig. 25-12, imagine that one spoke is rotated until it is parallel to the plane of the section. Do not section the spokes.



25-12. The spokes of this hand wheel not sectioned.

7. Do not section thin ribs and other parts that might make the section view confusing.

8. Section lining does not have to cover large areas completely. Place the section lining around the outline.

Section III

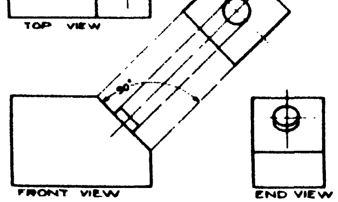
26. Drawing an Auxiliary View

In making a working drawing of an object that has a slanted or inclined surface, you have a special problem. For example, the meter case, Fig. 26-1, has no main view (front, top, or side) that shows the shape of the face to the correct size and shape. The round part appears as an ellipse on both the top and right side, or end, views. It is easy to see why this is so. In a three-view drawing all lines of the object must be at right angles to each other to appear true shape. A slanting surface (made of oblique lines) will always be shorter on any of the main views. To correct this an auxiliary (extra) view is made. This is a view you would see if you looked directly at the slanting face with your eyes at right angles to the surface. Fig. 26-2. Auxiliary views, then, are used primarily in making a working drawing of irregularly shaped objects.

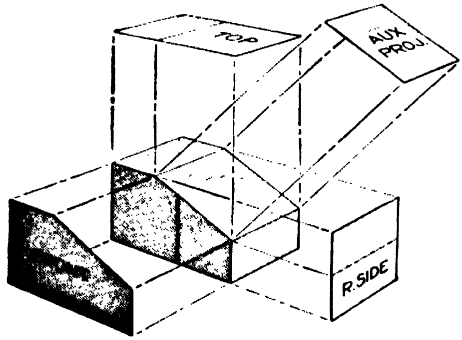
How many common objects can you think of that require an auxiliary view? A standard dial telephone or an antenna regulator that has a slanted face are two of them.

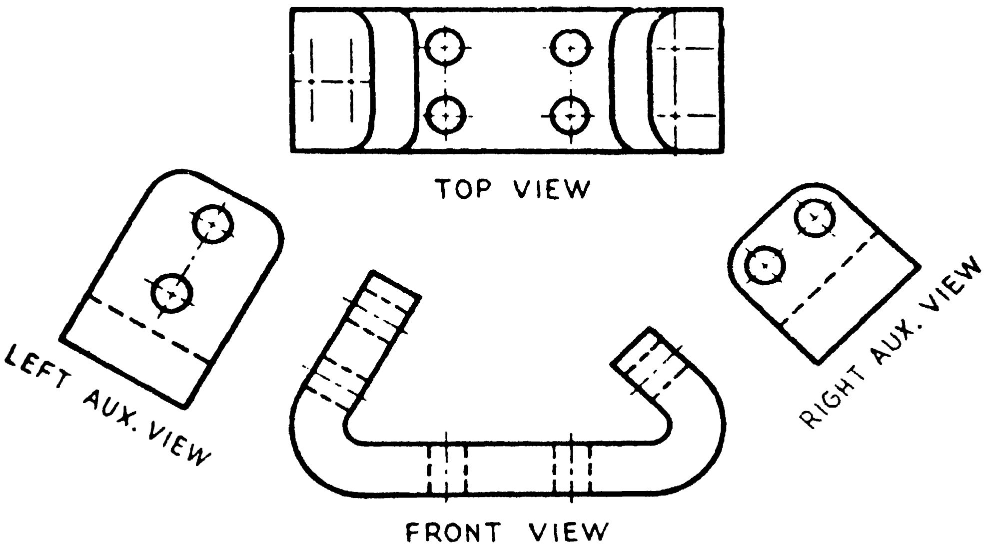
Auxiliary views are needed mostly in machine drawing. Many parts in mechanical and electrical objects such as brackets, connectors, or pipes are bent at an obtuse or acute angle. Fig. 26-3. Auxiliary views are needed to show these parts in true size and shape. Fig. 26-4.

26-1. An auxiliary view of a meter case. Notice that only in the auxiliary view is the round part shown in its true shape.



26-2. The auxiliary view, or projection, as it is sometimes called, is drawn as shown here.





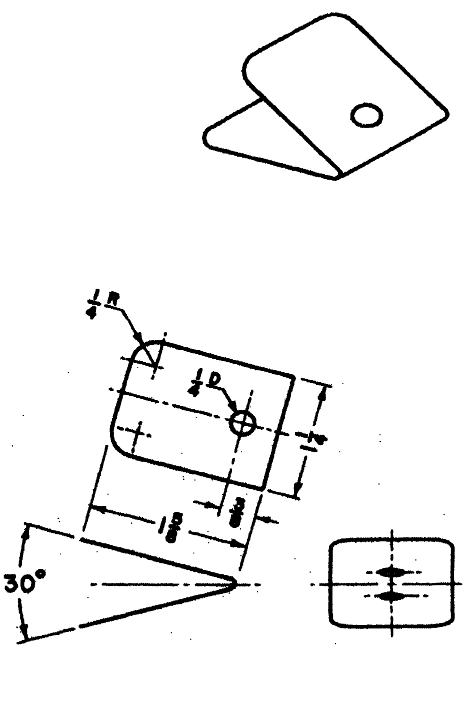
26-3. This bracket shows a typical use for an auxiliary view.

KINDS OF AUXILIARY VIEWS

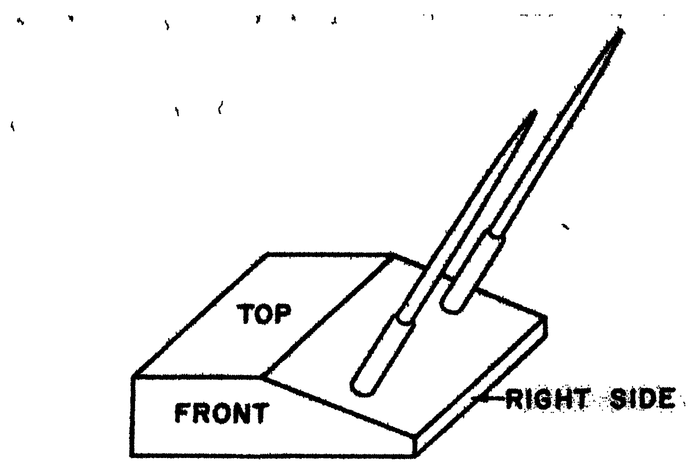
The shape of the object determines how the auxiliary view must be drawn. Irregular-shaped objects are of three general types:

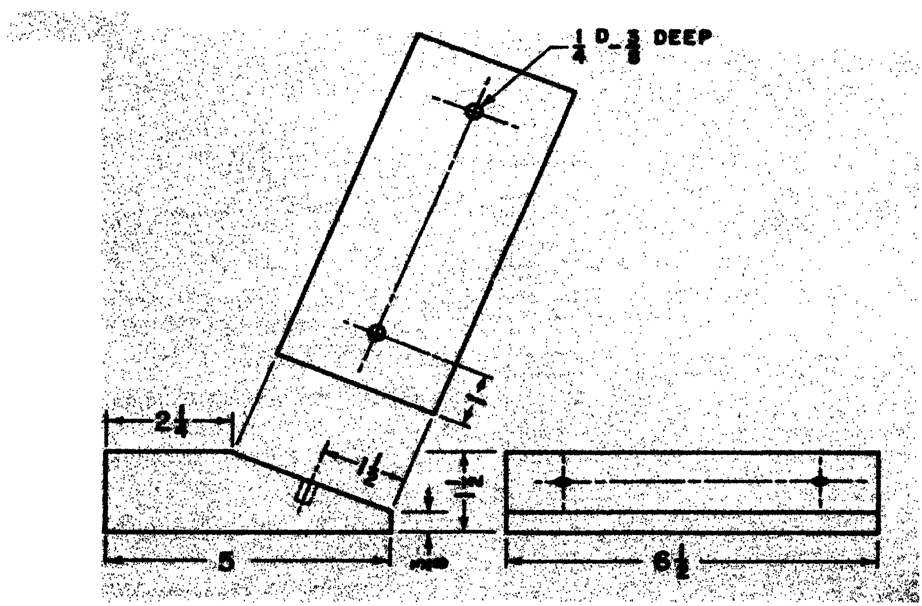
1. Those in which the slanted surface is from the *top* to the *right* (or left) side.
2. Those in which the slanted surface is from the *top* to the *front*.
3. Those in which the slanted surface is from the *front* to the *right* (or left) side.

An auxiliary view is always drawn or projected from the view in which



26-4. A drawing with an auxiliary view for a simple object—a sheet-metal whistle.





26-5. A drawing showing an auxiliary view of a pen holder. Of course, for an object as simple as this, it might not be necessary to make an auxiliary view.

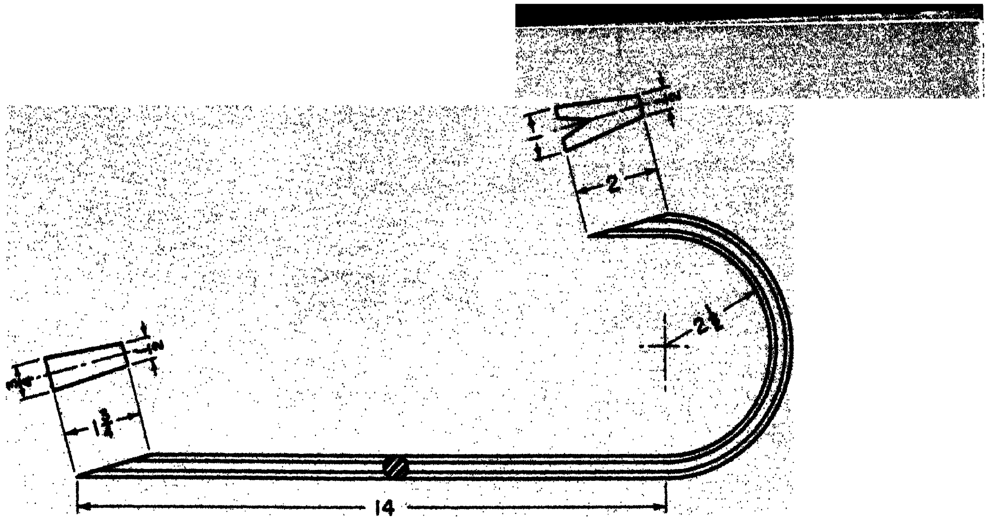
the slanted surface is shown as a line. For example, if the slanted surface is from the top to the right side, the auxiliary view is drawn or projected from the front view.

MAKING AN AUXILIARY VIEW

An auxiliary view is good for a project such as this pen holder. Fig. 26-5. Notice that the slanted surface is from the top to the right side. Therefore the auxiliary view will be drawn from the front view.

1. Draw the front view of the pen holder.

2. Draw the right side or top view.



1/2" OCTAGON TOOL STEEL 20"

26-6. An auxiliary view is needed for both ends of this crowbar. Notice that the revolved section of the crowbar makes use of symbols to show that the material is steel.

Usually only one additional view is needed. In this case it is better to draw the right-side view.

3. Draw light construction lines at right angles to the slant line on the front view. You now have the width of the auxiliary view.

4. Determine the length of the auxiliary view from the side view. Measure this length along one construction line and draw two light lines that are parallel to the slant lines on the front view. Locate the position of the hole using the front and side views for reference.

5. Complete the auxiliary view.

POINTS TO REMEMBER

1. In an auxiliary view draw only the slanted surface and not the entire view.

2. *Only one or two views are necessary in addition to the auxiliary view.* Fig. 26-5. Only in rare cases are all three views and an auxiliary view drawn.

3. The main views (front, top, and right side) may have to be placed farther apart than is normal so they will not interfere with the auxiliary view. Enough space must be provided for dimensioning.

4. An auxiliary view is needed for each slanted or inclined surface of the object. Fig. 26-6.

5. If the object is symmetrical (equal on both sides) draw a center line parallel to the slanted line and a convenient distance away. Use this line as a reference for making the auxiliary view.

6. If the auxiliary view contains an irregular line or curve, obtain the measurements from one of the main views and transfer them to the auxiliary view.

Section III

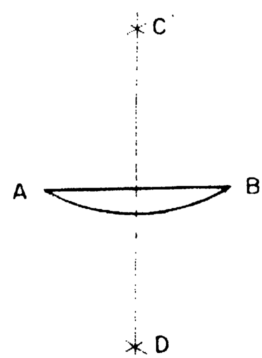
27. Doing Useful Geometric Construction

Many drawings and layouts contain geometric shapes. Some of these, such as a circle, square, triangle, or rectangle, are very simple. Many times you need to draw certain simple geometric constructions. There are many other constructions used by engineers and draftsmen but a few of the simpler ones include:

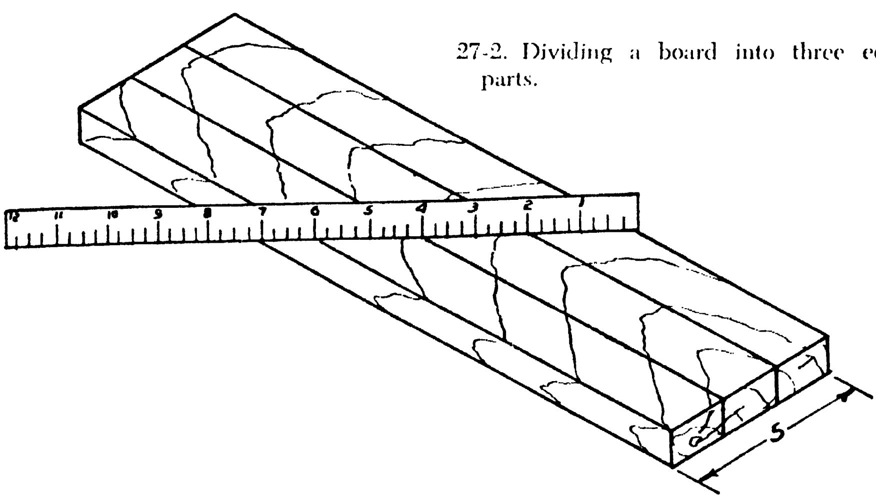
1. Bisecting a line or an arc (dividing it in two equal parts).

a. To bisect the line or arc AB, adjust a compass to a radius greater than one half AB.

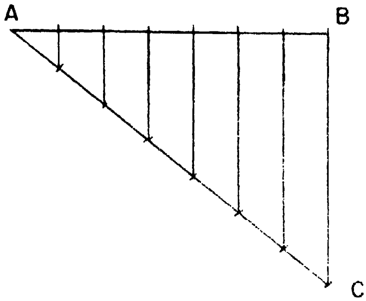
b. With A and B as centers, draw arcs that intersect at C and D.



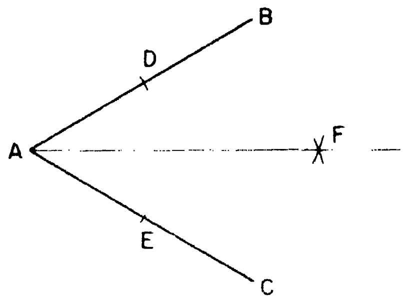
27-1. Bisecting a line or an arc.



27-2. Dividing a board into three equal parts.



27-3. Dividing a line into several equal parts.



27-4. Bisecting an angle.

c. Draw line CD. This will divide the line or arc AB into two equal parts.

2. Dividing a line into several equal parts. This procedure is used frequently in shop work when you have material of odd width to divide into several equal parts Suppose you want to divide a board 5″ wide into three equal parts. Hold the rule at an angle across the board with one end of the rule on one edge and the 6″ mark on the other. Fig. 27-2. Mark a point at 2″ and at 4″. This is the way to do it in drawing. Fig. 27-3.

a. Draw a line of any length, AB.

b. Draw a line, AC, at an angle to AB.

c. Starting at point A, lay off several equal divisions with a dividers, compass, or rule. The number of divisions is equal to the number of parts into which you wish to divide line AB.

d. Draw a line from the end of C to point B.

e. Draw lines parallel to BC at the division on AC. These lines will intersect AB and divide it into equal parts.

3. Bisecting an angle.

a. Draw the given angle BAC. Fig. 27-4.

b. Adjust the compass to a radius of about ¾″

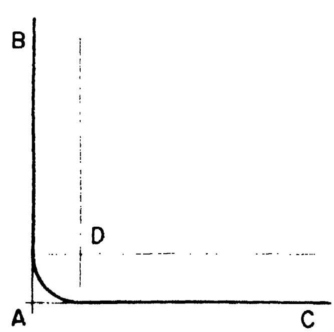
c. With A as the center, strike an arc intersecting AB at D and AC at E.

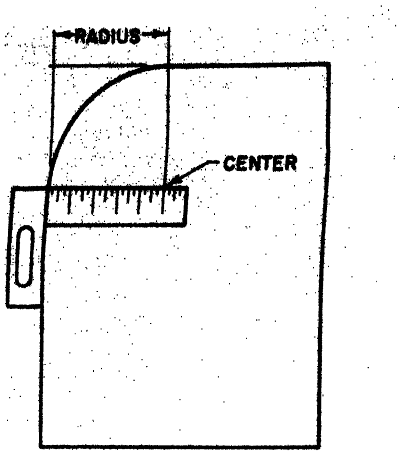
d. Adjust the compass to a radius of more than half ED.

e. With D and E as centers, strike two arcs that intersect at F.

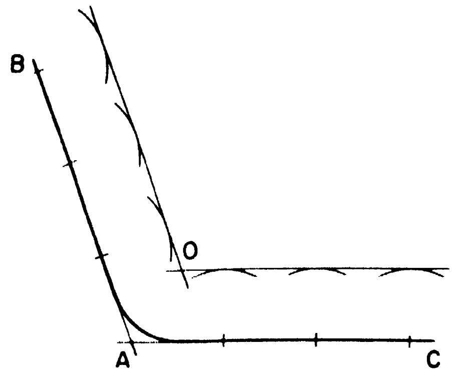
f. Draw the line AF to divide the angle into equal parts.

27-5. Drawing an arc at a square corner.





27-6. The shop method for drawing an arc at a square corner. Determine the radius of the arc. Mark this distance from the corner on the adjacent side and end. Hold a try square against the edge and end and draw two lines to locate the center. Use a dividers to draw the arc.



27-7. Drawing an arc to two lines that are not at right angles.

27-8. This spice holder has a back panel detail that has tangent arcs.

4. Drawing an arc at a square corner. Many projects you make have rounded corners to improve the appearance of the object and for utility. In geometry this would be called drawing an arc tangent to lines at 90 degrees. Fig. 27-5.

a. Draw the two lines, AB and AC, that intersect at A.

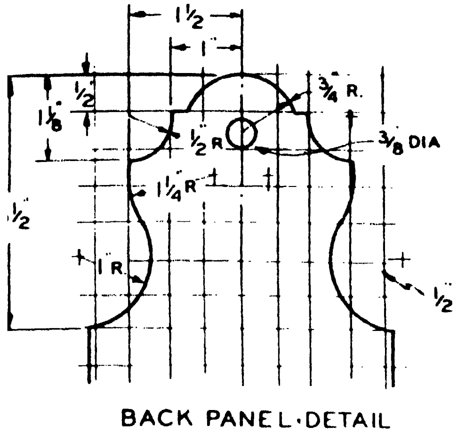
b. Determine the radius of the arc.

c. Measure in from lines AC and AB this distance and draw parallel lines to these lines that intersect at D.

d. Use D as the center and draw the arc.

e. This procedure may be followed in the shop as shown in Fig. 27-6.

5. Drawing an arc tangent to



27-9. A drawing of the back panel detail showing tangent arcs.

two lines that are not at right angles. Fig. 27-7. Sometimes an irregular shaped object has a rounded corner. This can be shown as follows:

a. Draw two lines to represent the edges of the materials, AB and AC.

b. Determine the desired radius of the arc.

c. Adjust the compass or dividers to this amount.

d. At several points along both lines, draw small arcs e, f, g, h, etc.

e. Draw straight lines tangent to these arcs until they intersect at O.

f. Using O as center, strike the arc.

6. Drawing tangent arcs. Many irregular-shaped objects such as machine parts or Early American furniture pieces have arcs or circles that are tangent. Figs. 27-8 and 27-9. Arcs or circles are tangent when they touch at only one point but do not intersect. To join a series of arcs, proceed as follows. (Fig. 27-10):

a. With O as center and R1 as radius, draw the first arc.

b. With P as center and R2 as radius, draw the second arc.

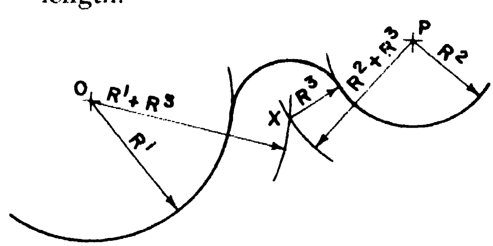
c. With O as center and R1 plus R3 as radius, strike a small arc at the approximate center location for the third arc.

d. With P as center and with R2 plus R3 as radius, strike a second arc that intersects at X.

e. With X as center and R3 as radius, strike the last arc.

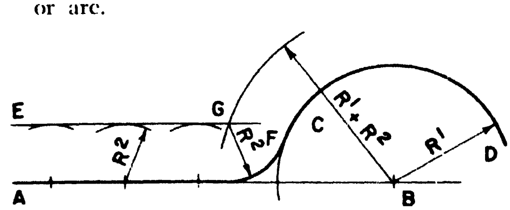
7. Drawing an arc with a given radius tangent to a straight line and a circle or arc. Fig. 27-11. The procedure is used often in drawing machine parts. Proceed as follows:

a. Draw line AB to the desired length.



27-10. Drawing a series of tangent arcs that join.

27-11. Drawing an arc with a given radius tangent to a straight line and a circle or arc.



b. With B as center and with a *compass adjusted* to radius R1, draw arc CD.

c. Draw a line (EF) the given radius (R2) above and parallel to line AB.

d. With B as center and with R1 plus R2 as radius, strike an arc that intersects the parallel line at G.

e. With G as center and the compass set at R2, draw the arc joining the straight line and the arc or circle.

8. Drawing an octagon. An octagon has eight equal sides and angles. Fig. 27-12. It is often used as a shape for metal or wood projects such as wastepaper baskets, hot-dish holders and metal trays. It might be the shape of a ticket in printing also.

a. Draw a square of the size of the octagon.

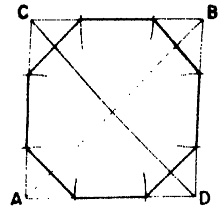
b. Draw diagonal lines AB and CD.

c. Adjust the compass to half the length of one of the diagonal lines.

d. Using points A, B, C, and D as centers, strike arcs intersecting the sides.

e. Connect the points where the arcs intersect the square.

9. Drawing a hexagon. A hexagon has six equal sides and angles. Fig. 27-13. It's another shape we use often in shopwork. For example, you might make a center punch or cold chisel from hexagon-shaped stock. The heads of many bolts and nuts are hexagons. To draw a hexagon:



27-12. Drawing an octagon.

a. Draw a circle with a radius equal to one side of the hexagon.

b. Set the compass equal to the radius of the circle.

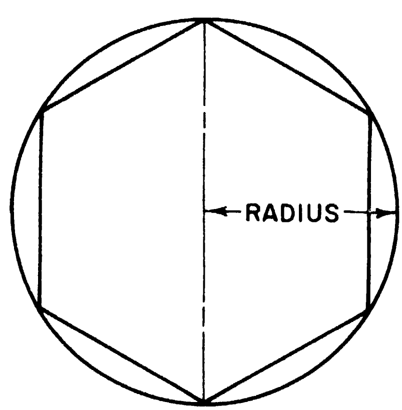
c. Start at any point on the circle and draw an arc.

d. Move the point of the compass to this point and strike another arc. Divide the circle into six equal parts.

e. Connect these points.

10. Drawing an ellipse. An ellipse is a regular curve that has two different diameters. It is a flattened circle. You find this shape often in the tops of tables, on plaques, and in the backs of lamps. Fig. 27-14. Wherever anything round is shown in isometric, draw an ellipse.

27-13. Drawing a hexagon.

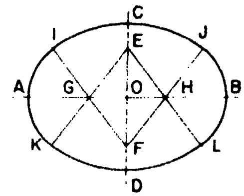


a. Draw the major and minor axes at right angles to each other, AB and CD.

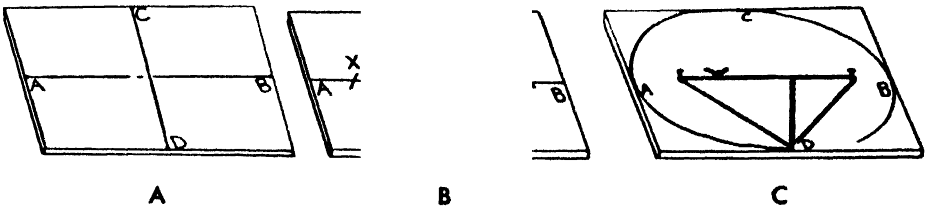
b. Lay out OE and OF, which are equal to AB minus CD.

c. Make OH and OG equal to three fourths of OE or OF.

d. Draw lines EK, EL, FH, FG.



7-14. Drawing an ellipse. This method can be used only if CD is at least two-thirds of AB.



7-15. A shop method for drawing an ellipse.

e. Using E and F as centers and ED as radius, strike arcs IJ and KL.

f. Use G and H as centers and GA as radius. Strike arc IK and JL.

There is another shop method of drawing the ellipse that is very simple. You will want to use it:

1. Draw the major and minor axes AB and CD. Fig. 27-15.

2. Set the dividers equal to half the longest diameter.

3. Using D as center strike an arc intersecting AB at X and Y.

4. Place a pin at X, Y and B. Tie a string around these three pins.

5. Take the pin at B away and put a pencil point in its place.

6. Hold the point of the pencil tight against the string. Carefully draw the ellipse.

PROBLEMS—SECTION III

Section III—QUESTIONS AND TOPICS FOR DISCUSSION

1. What tools are included in a set of instruments?
2. Name the two kinds of compasses.
3. What kind of pencil lead should be used in a compass?
4. What is the dividers needed for?
5. Describe the architect's scale. For what kind of drawing would you use this scale?
6. What is an engineer's scale used for?
7. What is a template?
8. What does a section view show?
9. When the front view is cut away it has what term applied to it?
10. What does the cutting-plane line show?
11. What part has been cut away in a half section?
12. What is a removed or detail section?
13. How is section lining or cross hatching used?
14. What kind of surface requires an

15. What are some important points to remember in drawing auxiliary views?

16. Explain the procedure for the following: (a) bisecting a line or arc, (b) dividing a line into several equal parts, (c) bisecting an angle, (d) drawing an arc at a square corner, (e) drawing an arc tangent to two lines that are not right angles, (f) drawing tangent arcs, (g) drawing an arc with a given radius tangent to a straight line and a circle or arc, (h) drawing an octagon, (i) drawing a hexagon, (j) drawing an ellipse.

Section III—SELF-CHECKING WHAT YOU HAVE LEARNED

PART I. True-False

1. It is necessary to have an expensive set of drawing instruments to make a useful drawing.

2. The taper on the lead of a compass should be on the inside.

3. A dividers is similar in appearance to a compass.

4. To divide a line into equal parts, adjust the dividers by trial and error and space off the line.

5. The architect's scale is made in either a flat shape or a triangular shape.

6. Most drawings of rooms, buildings and house plans are made to one-fourth full size.

7. A line showing where the object has been cut to make the section view is called the cutting-show line.

8. Numbers are placed under each section view to identify it.

9. Symbols for material tell exactly the kind of material that is shown in section.

10. Bolts, nuts, rivets and other fasteners are never sectioned.

11. Auxiliary views are made as a part of a working drawing of irregularly shaped objects.

12. In making an auxiliary view always draw the entire view and not just the slanted surface.

13. To bisect an angle means to divide the angle into two equal parts.

14. A hexagon has nine equal sides and angles.

15. Laying out a round corner on a square table top would be drawing an arc tangent to lines at 90 degrees.

16. A scale of $\frac{1}{2}'' = 1'$ means that the drawing would be one twenty-fourth size.

PART II. Fill In

1. The two kinds of compasses are the ________ joint and the ________ joint.

2. The pencil lead should be about ________ inch shorter than the metal point of the compass.

3. Dividers are used to lay off equal distances on a ________ or ________ line.

4. The smallest readable division on the scale $3'' = 1'$ is ________ inch.

5. To make a full-size drawing with an engineer's scale, use the scale marked ________

6. Plastic devices with different shaped cutouts are called ________.

7. A drawing in which the front half of the object is cut away to make a view is called a ________.

8. Cross hatching or ________ are used to show the areas that are cut on a section view.

9. When the slanted surface of an irregular object is from the front to the right side, the auxiliary view is drawn or projected from the ________ view.

10. A line that has been bisected is divided into ________ equal parts.

11. An octagon has ________ equal sides and angles.

12. An ______ is a regular curve that has two different diameters.

13. Circles, squares, triangles and rectangles are examples of simple ______ shapes.

Section III—APPLYING WHAT YOU HAVE LEARNED:

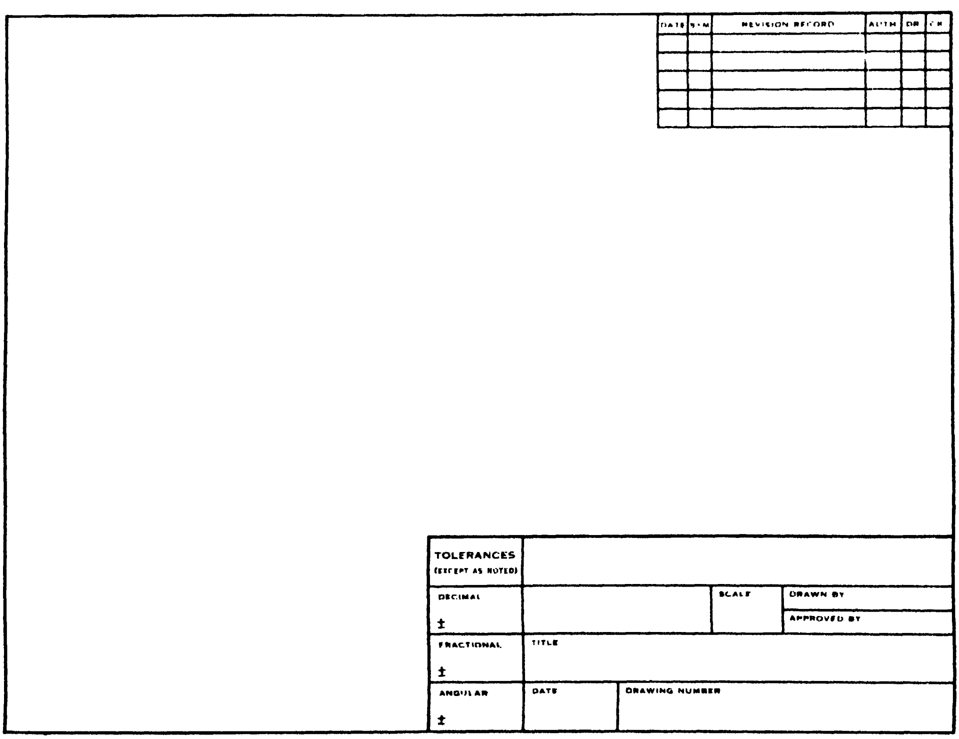
ACTIVITIES, THINGS TO DO, PROBLEMS, EXPERIENCES

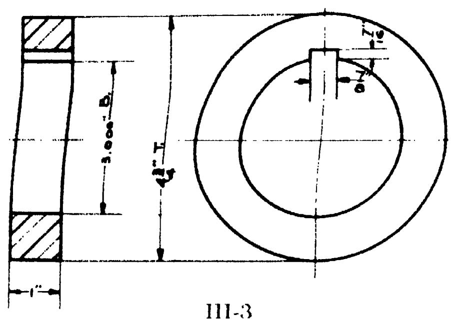
Most of the problems or activities in this section are detail drawings of simple machines and mechanical parts. However, *they are not simple drafting problems.* You will notice that several of the problems are of parts from things you see or use every day, such as model trains, bicycles, musical instruments, and motorcycles. These are the kinds of drawings you must learn to do if you plan to become a draftsman, designer, or engineer. Completing one or more of these drawings should give you an appeciation of the time, thought, and work necessary for drawing and designing even the simplest part for the mechanical objects you use every day. If necessary, make the drawings on Size B (11″ x 17″) paper. Use a title block or record strip. For simpler drawings title 2 on size B as shown in Fig. 6-7 could be used.

1. Draw six 1″ x 1½″ rectangles and show the symbols for the following materials: cast iron, steel, brass, aluminum, zinc, and wood.

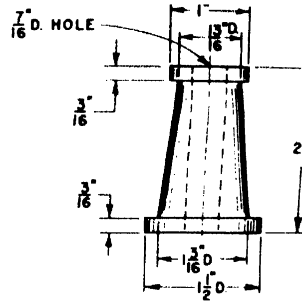
2. Make a drawing of the fishing-line

III-A





III-3



spool shown in Fig. 25-3. Draw it twice the size shown. Make the front view in full section.

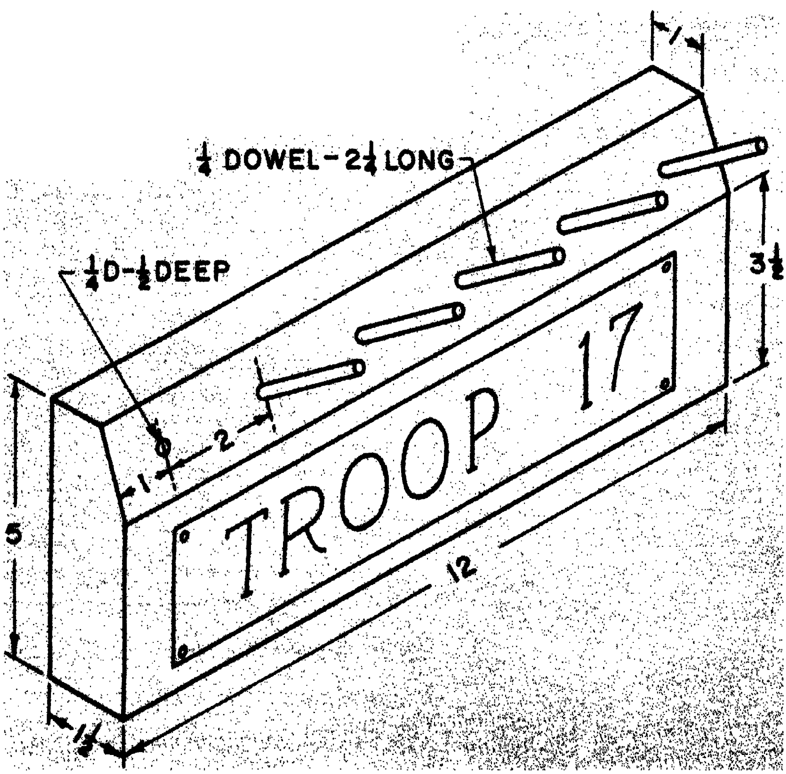
3. Draw the drill-press collar shown in Fig. III-3. Make a full section front view.

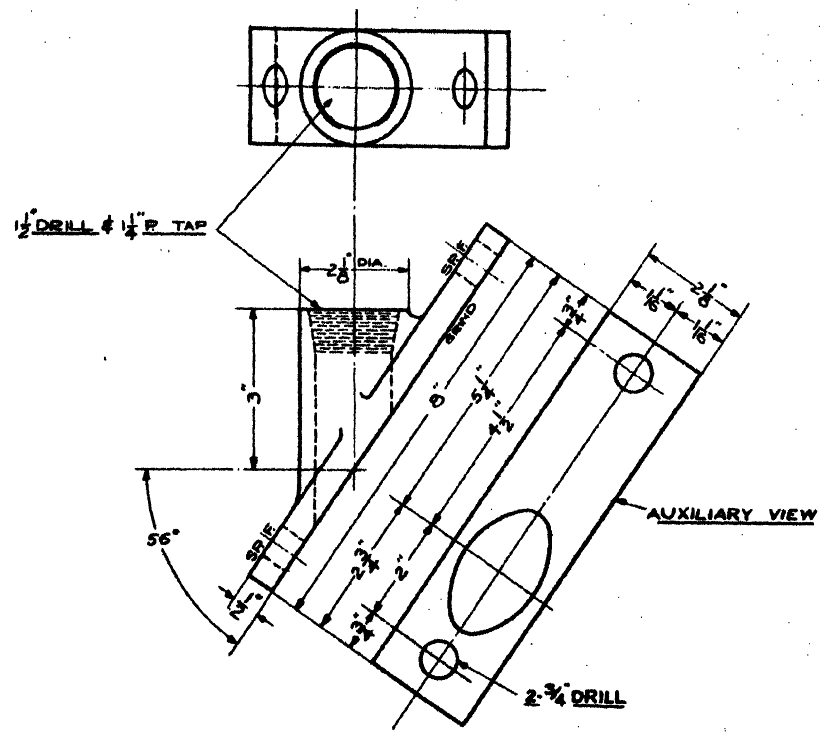
4. Draw the rivet set, Fig. 25-9.

5. Fig. III-5 shows a brass collar for a lamp. Make a full-section front view and show the cutting plane line on the top view.

6. Draw the sheet-metal whistle shown in Fig. 26-4.

III-12





III-13

7. Make a drawing of the crow bar in Fig. 26-6 to some suitable scale. Include the revolved section and the auxiliary views.

8. Complete a full section and an auxiliary view of the bracket shown in Fig. 26-3.

9. Complete the following:
   a. Divide a 2½" line into two equal parts.
   b. Divide a line 3¾" long into five equal parts.
   c. Divide a 38-degree angle into two equal parts.
   d. Draw an octagon inside a circle that is 2" in diameter.
   e. Draw a hexagon that is 2¾"across the flats.

10. Draw an ellipse for a table top that is 16" x 22". Make it to some suitable scale.

11. Make a full-size pattern for the back panel detail in Fig. 27-9.

12. Complete the drawing of the coat rack, Fig. III-12. Add an auxiliary view.

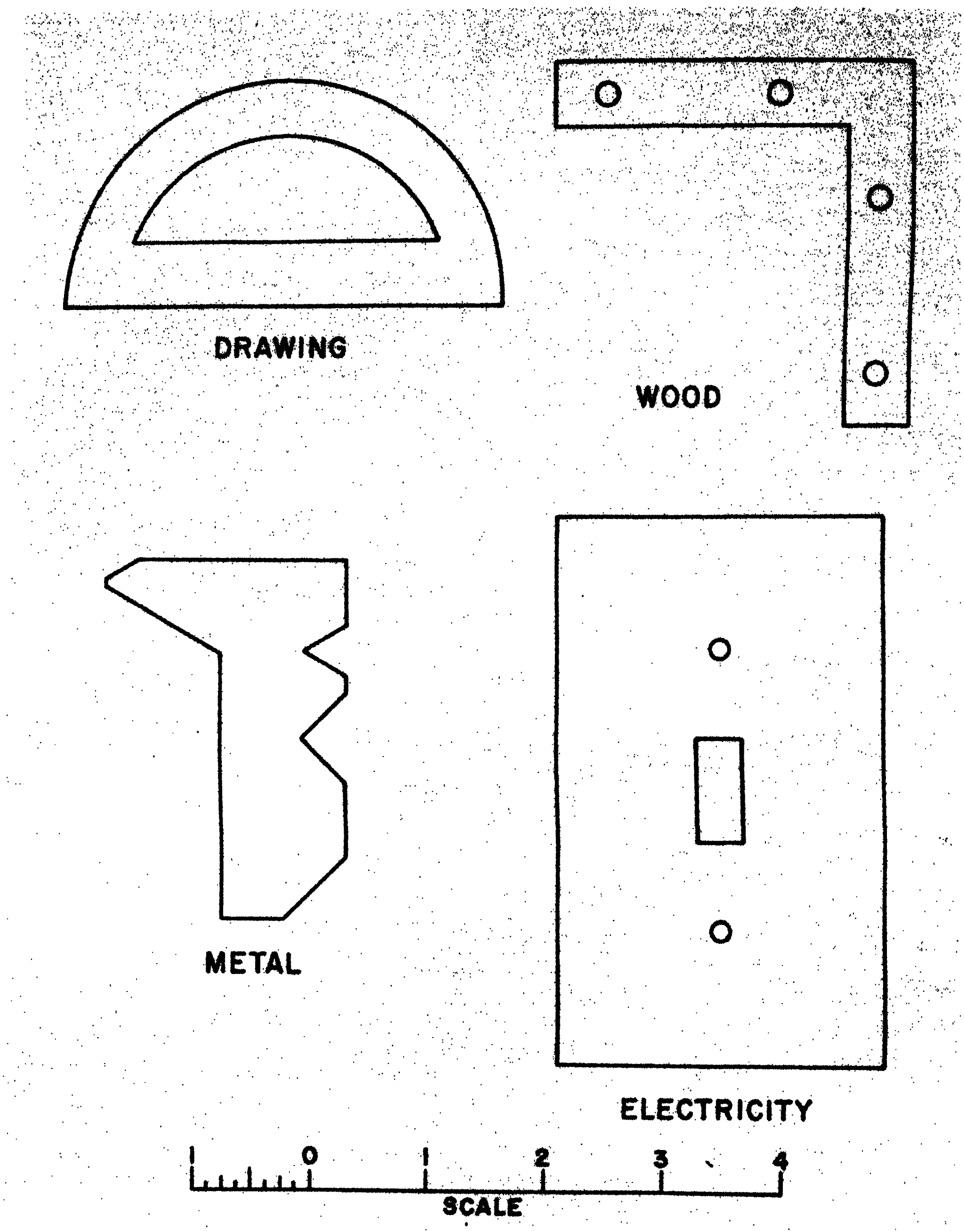
13. Make a complete drawing including the auxiliary view of this floor flange. Fig. III-13.

14. Complete a full-size drawing of these common items found in the school shop. Use your dividers on the object. Then find the full size by using the scale. Add the dimensions. Can you name each item? Fig. III-14.

15. Here you see a detail drawing of one part of the clutch assembly—a clutch disc—of a motorcycle. Fig. III-15. Draw it full size. Notice that the dimensions are given in decimals instead of fractions.

16. Fig. III-16 shows a drawing of the side rod of a model railroad engine. Make a double-size drawing of this part. Add the dimensions in decimals and in fractions.

17. Here you see a photograph of a bicycle with a detail drawing of the front

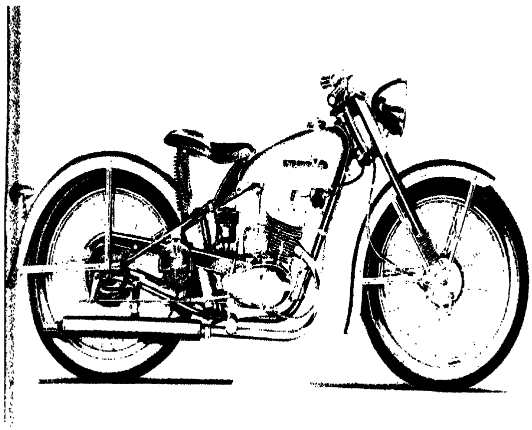


III-14

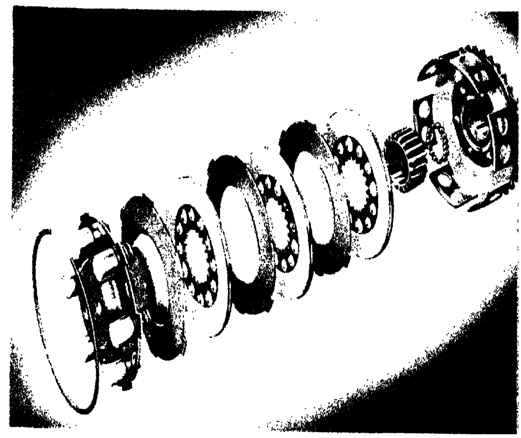
hub. Fig. III-17. Notice that all the dimensions are given in decimals instead of fractions. Make a broken-out section on the left half of the hub.

18. Make a drawing to some suitable scale of the stem, handelbar assembly. Fig. III-18. Notice how difficult a drawing this is in spite of the fact that this is only a very small part of a bicycle.

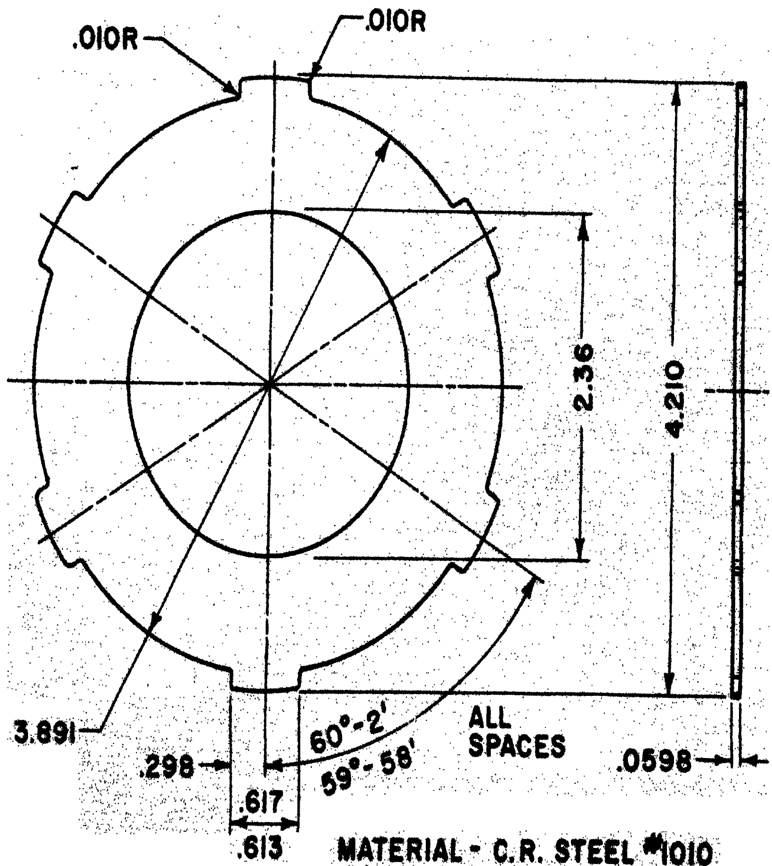
19. Here you see a clarinet with some



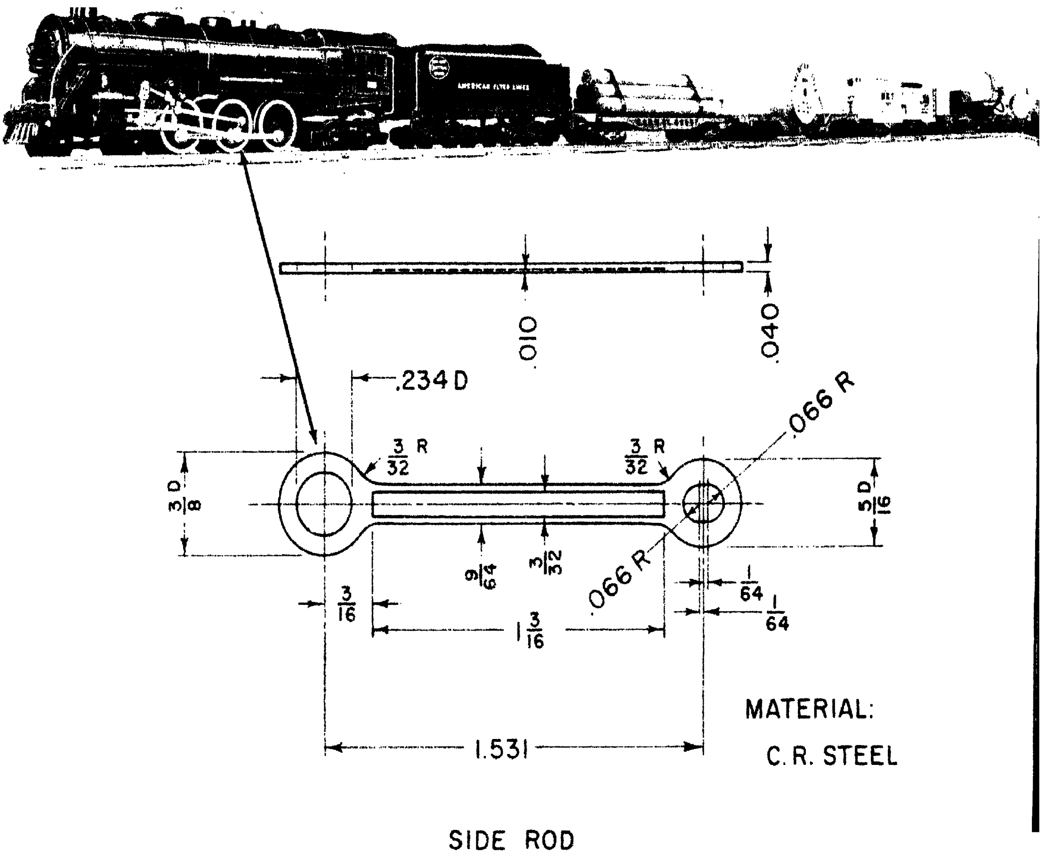
III-15A



III-15B



III-15C



III-16

of the parts lettered. There are detail drawings for each of these parts. Fig. III-19.

a. Make a one-view and full-section drawing of the barrel ring. Part III-19B.

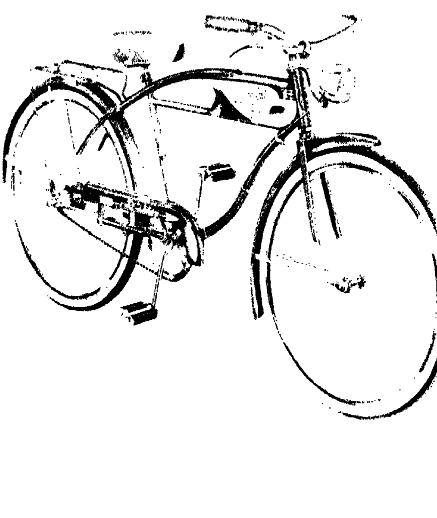
b. Make a two-view drawing of this thumb ring. Part III-19C. This is called a tabular drawing. Notice that letters are used for some dimensions instead of numbers. One drawing can then be used to make these thumb rings of several different sizes. The chart in the upper left-hand corner of the sheet shows the sizes.

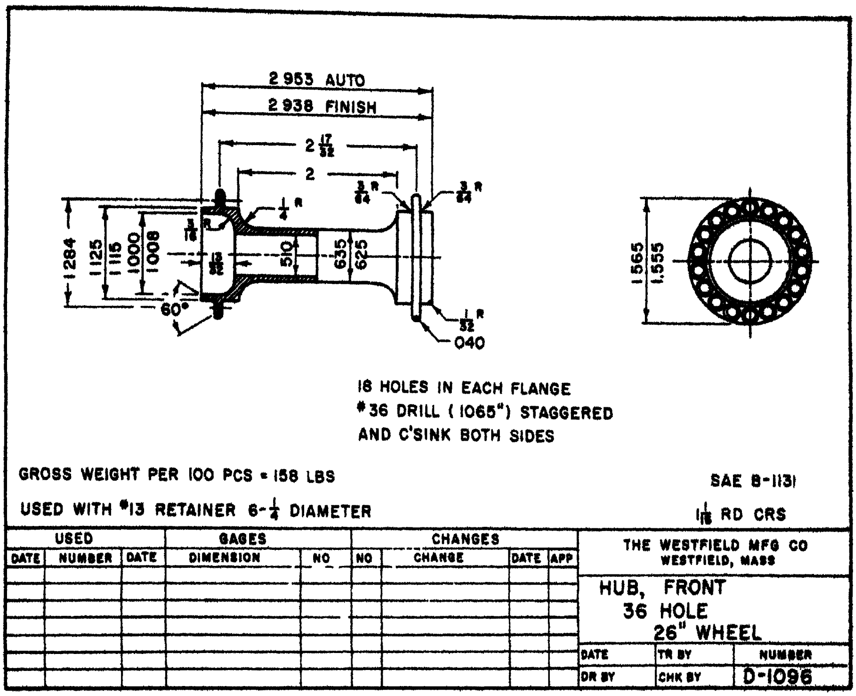
c. Complete a two-view drawing of the thumb tube. Part III-19D.

20. Draw two views of this sectional plate bolt and washer. Fig. III-20. Use simplified thread symbol as shown in Fig. 29-11.

21. Draw two views (front and top) of this transformer stud. Use simplified thread symbol. Make the bottom view in full section. Place the cutting-plane line just above the lower threaded portion of the stud. Fig. III-21.

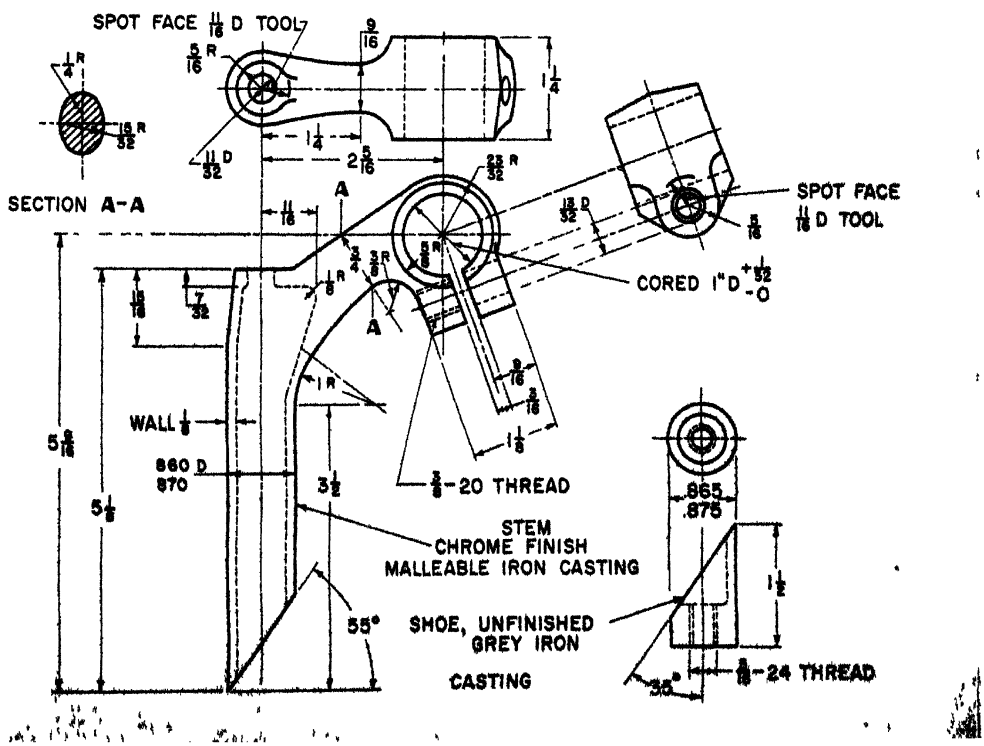
III-17A



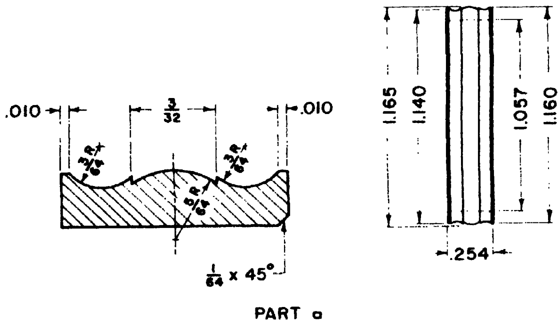


Ill 17B

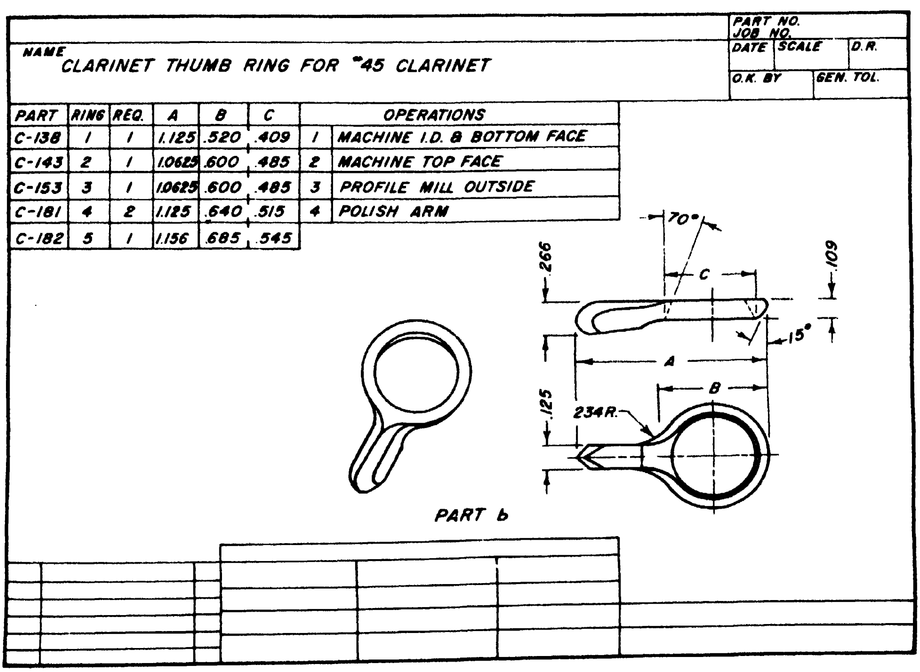
Ill 18



III-19A



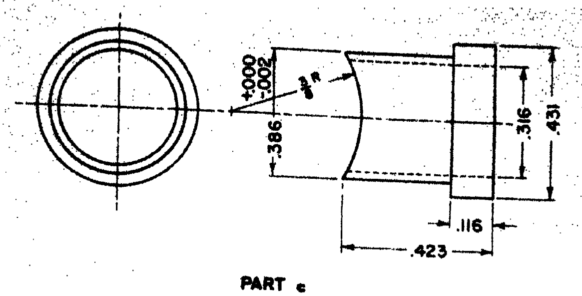
III-19B



PART	RING	REQ.	A	B	C
C-138	1	1	1.125	.520	.409
C-143	2	1	1.0625	.600	.485
C-153	3	1	1.0625	.600	.485
C-181	4	2	1.125	.640	.515
C-182	5	1	1.156	.685	.545

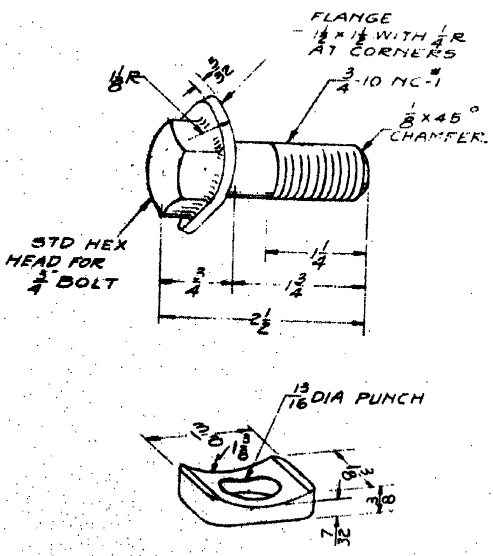
	OPERATIONS
1	MACHINE I.D. & BOTTOM FACE
2	MACHINE TOP FACE
3	PROFILE MILL OUTSIDE
4	POLISH ARM

III-19C

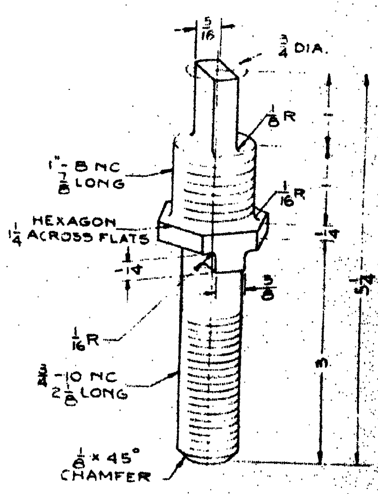


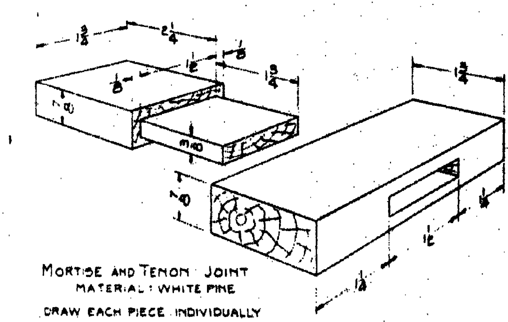
III-19D.

III-20

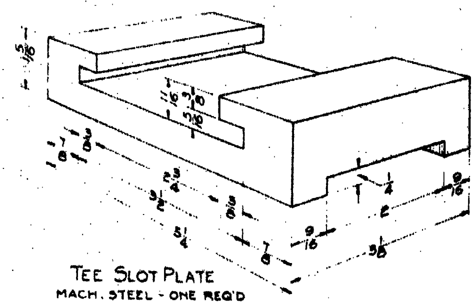


III-21

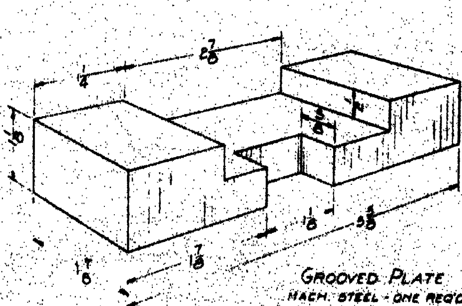




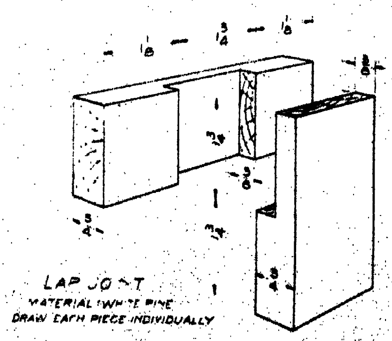
III-22



III-23



III-24



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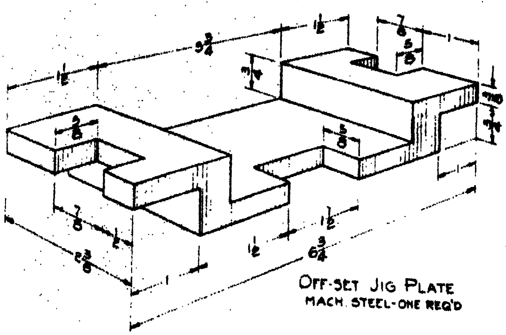

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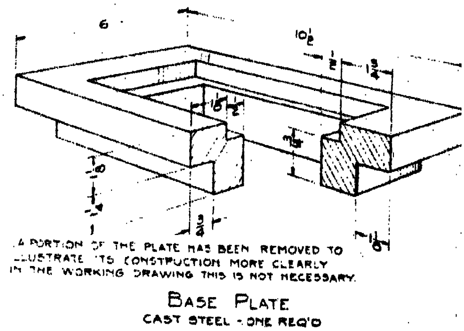

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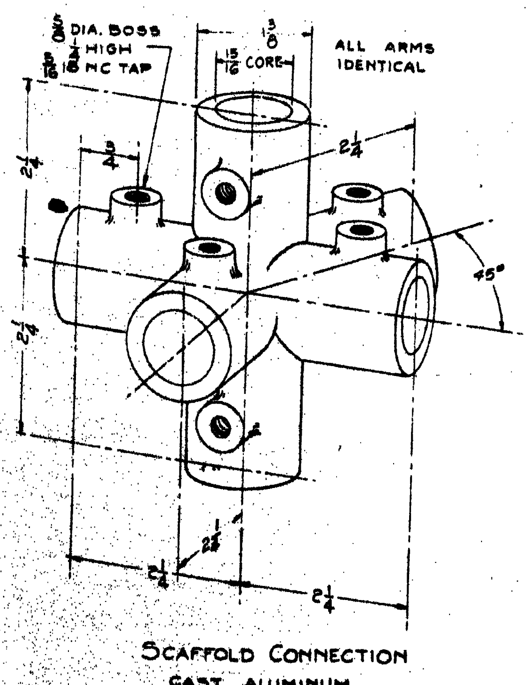
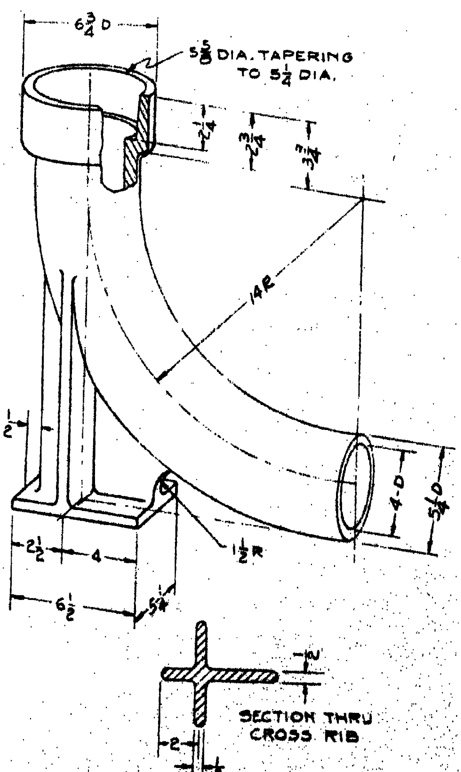
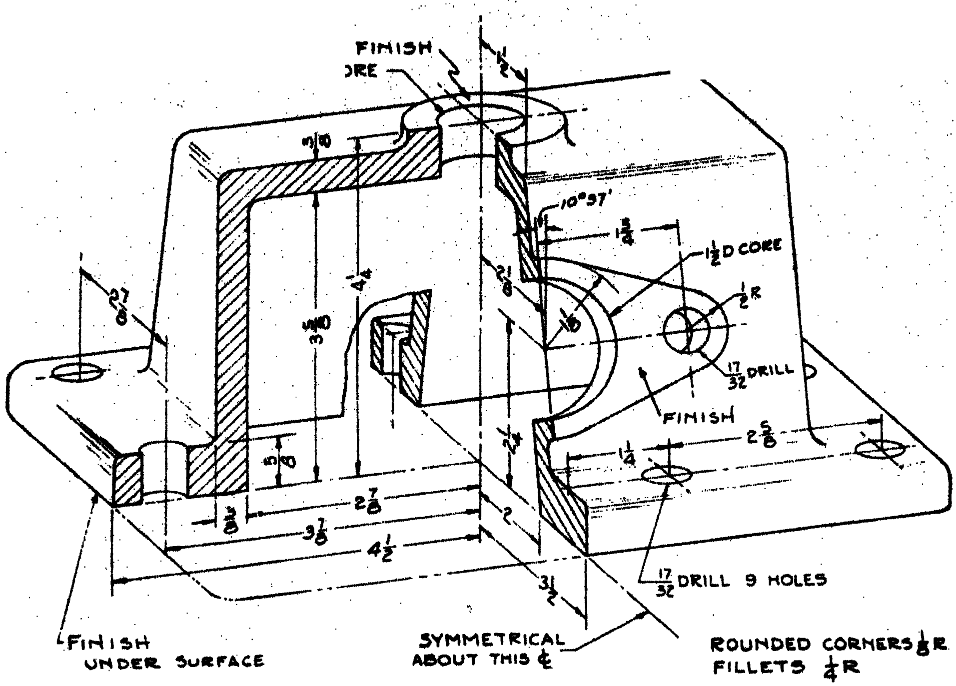


III-28



III-29



GEAR BOX COVER
CAST IRON

22. Draw two views of each part of this mortise and tenon joint. Fig. III-22.

23. Make a three view drawing of this Tee Slot Plate. Fig. III-23.

24. Complete a three-view drawing of this grooved plate. Fig. III-24.

25. Draw two views of both parts of this lap joint. Fig. III-25.

26. Complete two views (front and top) of this off-set jig plate. Fig. III-26.

27. Make a three-view drawing of this base plate. Fig. III-27.

28. Make a front and top view of this cast aluminum scaffold connection. Show a broken-out section across the entire horizontal member. Fig. III-28.

29. Construct a one-view working drawing of this catch basin elbow. Fig. III-29. Make a removed section looking down on the cross rib about 1" up from the bottom.

30. Construct one-view (top) looking directly down on this gear box cover. Fig. III-30. Add a full-section (B-B') view to the right of this top view. Add another full-section (A-A') view below this top view. Construct an auxiliary view of the gasket plate to the right of the lower section view.

Section IV: SHOP DRAWING

HERE is a *preview* of the things you will learn in *shop drawing* . . . what you should know and be able to do after you have studied the units in this section:

1. Tools, materials, and fasteners used in woodworking and how to draw them.
2. Some special points to note about woodworking drawings.
3. Several kinds of woodworking drawings.
4. How to make a working drawing from a picture or sketch.
5. Shapes and kinds of metal.
6. How metal parts are fastened together.
7. Screw threads, what they are and how to draw them.
8. Threaded metal fasteners.
9. Other metal fasteners including rivets.
10. Sheet-metal pattern development.
11. Drawing practices to observe in some areas of metalworking such as bench metal or wrought iron, art metal, foundry, machine shop, and welding.
12. Drawing in low-voltage wiring, house wiring, appliance service and repair, and communication devices.
13. Electrical project drawings.
14. Graphic arts, including printing, linoleum-block printing, and silk-screen printing.
15. How to draw, make layouts, and make designs in graphic arts.
16. The things involved in arts and crafts such as plastics, leather, archery, wood carving, and model making.
17. How drawings are made and used in arts and crafts.
18. How to make simplified shop drawings.

Section IV

28. Woodworking Drawing

Drawings and plans are needed for all kinds of woodworking. For a very simple project a shop sketch will be enough. To build a piece of furniture a more complete drawing is necessary. The carpenter must have a set of blueprints to build a house. The patternmaker needs a special kind of drawing to make the wood patterns for castings.

KINDS OF TOOLS AND MATERIALS

Projects in woodworking are made of wood, plywood, and many kinds of man-made materials with a chip or pulp base. For most projects you probably will use such common woods as pine, mahogany, walnut, oak, birch, or maple.

Wood is measured by the board foot. A piece that is 1″ thick, 12″ wide, and 12″ long is a *board foot.* Stock that is less than 1″ thick is figured as 1″. Stock above 1″ thick is figured according to its exact thickness. *Board feet* equal thickness in inches times width in inches times length in inches, divided by 144, or $BF = \frac{T'' \times W'' \times L''}{144}$. Some lumber such as molding or trim is sold by the linear (running) foot. Plywood is purchased in sheets from 2′ x 4′ to 4′ x 8′. It is available in standard thicknesses of ¼″, ⅜″, ½″, etc., and is sold by the *square foot.*

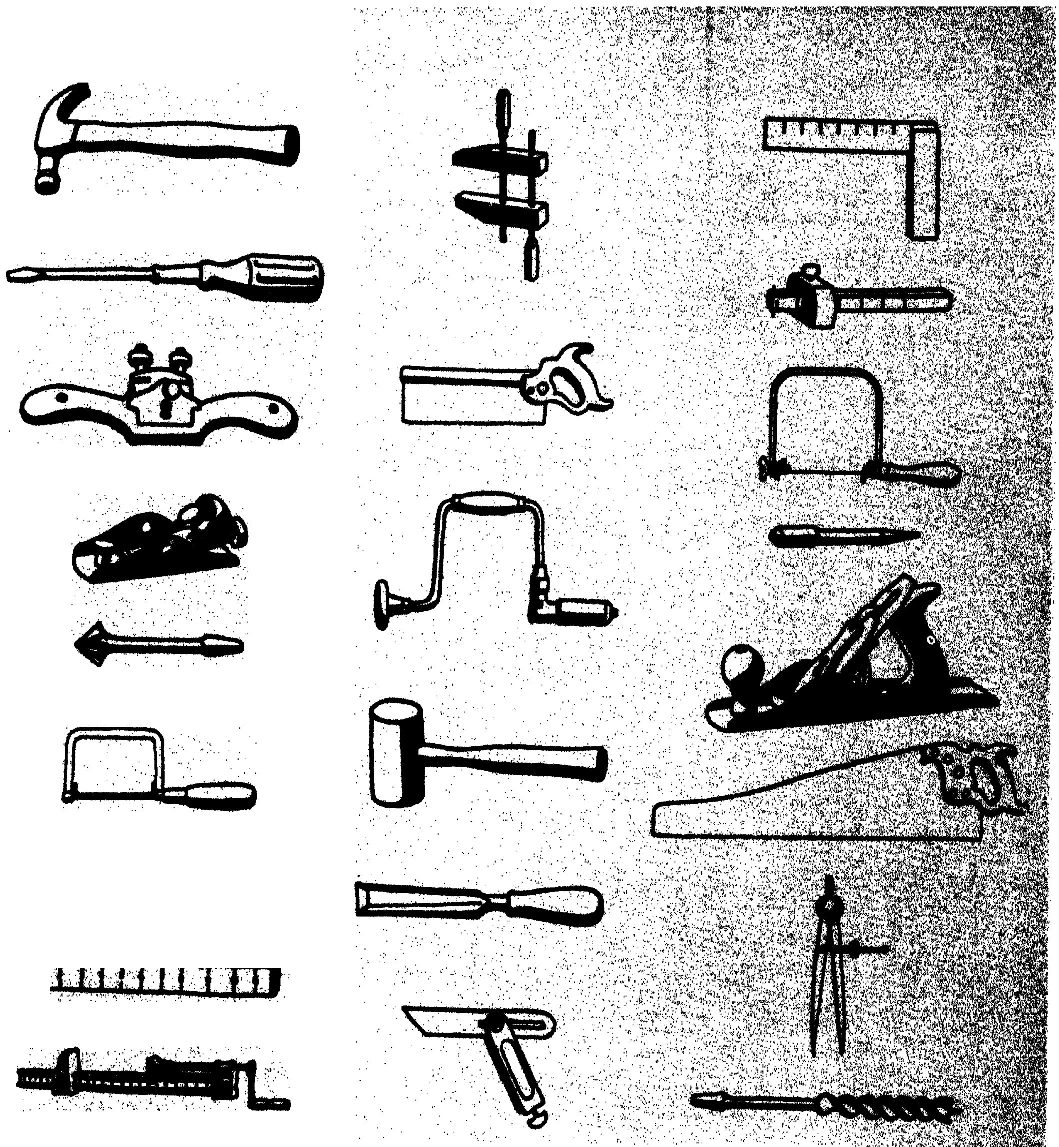
Some of the common hand tools you will use in beginning woodworking are shown in Fig. 28-1. You can get acquainted with these by making sketches of them.

You should make use of the symbol for wood when it is shown in section or when the end view is shown. Fig. 28-2. Fig. 28-3 shows the more common cuts in woodworking.

KINDS OF FASTENERS

There are four common ways to join wood pieces together. Often you will use more than one method on the same project. The method of fastening is shown either as part of the drawing or in a note. Sometimes the bill of materials lists the fastening devices.

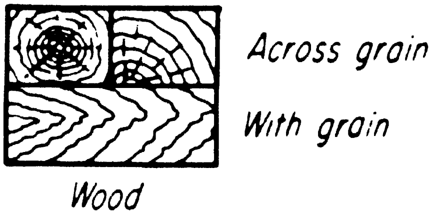
Joints. There are more than 100 varieties of woodworking joints. These are variations of only *eight basic ones* shown in Fig. 28-4. Joints are given added strength by installing dowels or splines. Dowels or splines are often shown by invisible lines on the drawing or are indicated by a note. Fig. 28-5. For example, for a



28-1. Common hand tools used in woodworking. Can you name and sketch each one?

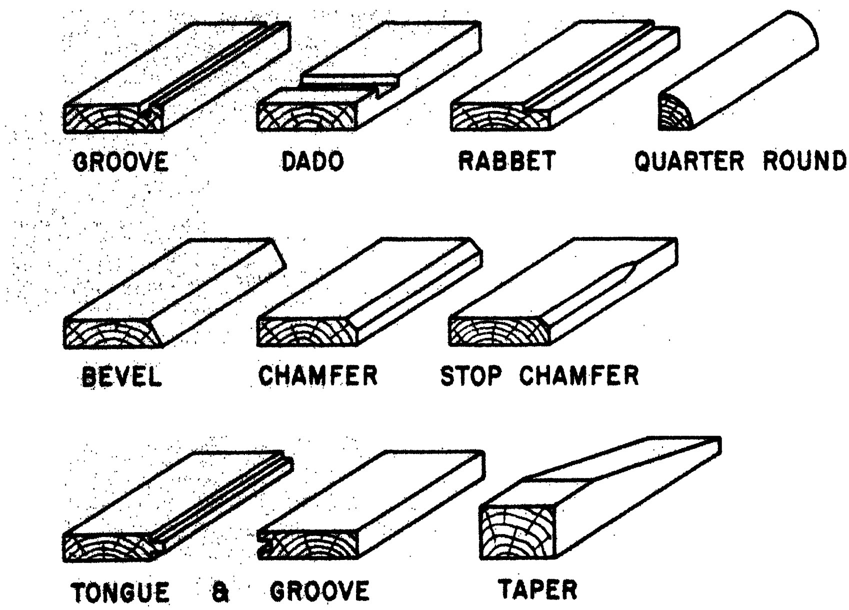
miter joint the note might say, "Add two dowels."

There is no set practice for drawing joints. Some joints are very obvious, such as the simple miter joint on a frame. Other drawings may show only the exterior of the joint with a note added to indicate the type. A large surface for a table top may be assembled with butt joints strengthened with dowels. Certain drawings may have hidden lines showing the joint. An example of this might be a mortise-and-tenon joint. Fig. 28-6. In a few cases a detail of the joint may be drawn for clarity. Fig. 28-7. Most woodworking drawings do not clearly show the



28-2. Wood in section.

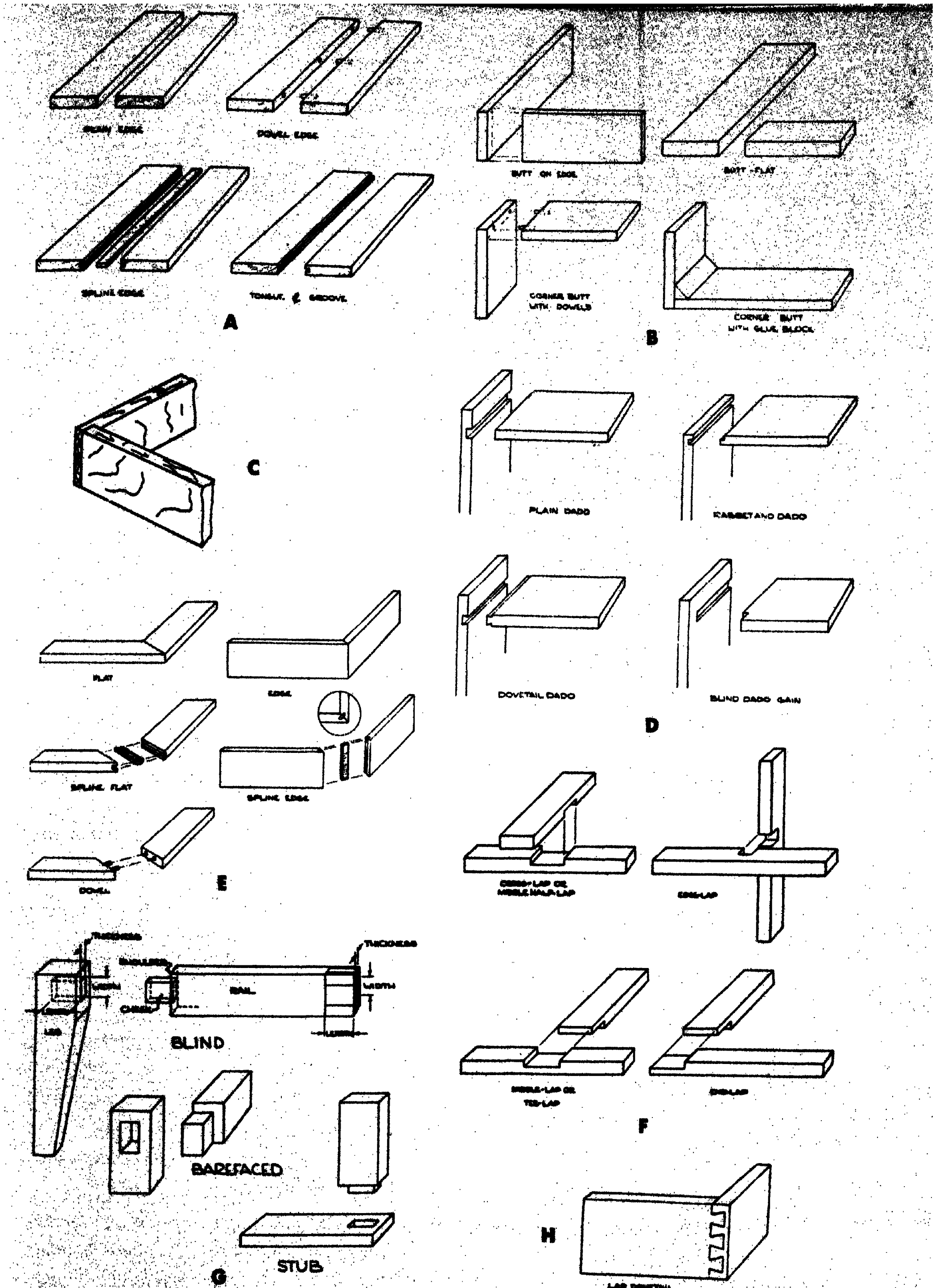
28-3. Common cuts in woodworking.



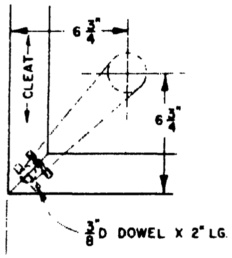
kind of joint to use. The craftsman must decide on the best kind and size.

Wood Screws. Wood screws are made of brass or mild steel. The common head shapes are round, flat, and oval. Fig. 28-8. The round head of mild steel is usually made in a blue finish and the others in a bright finish. The size of the screw is shown by the gauge number and the length. The gauge number ranges from O, the smallest, to 24, the largest. The length varies from ¼" to 6". *Wood screws are not drawn in detail* on most woodworking drawings. Sometimes a small circle with a double line across the center represents the end view of the screw. In some drawings the outline of the screw in hidden or invisible lines is shown on one or more of the other views. Fig. 28-9. The most common method is to indicate the size of screw by a note, such as 4-No. 5 1½"-FH. This means that you should use four No. 5 gauge flat head screws that are 1½" long. If this information isn't given as a note,

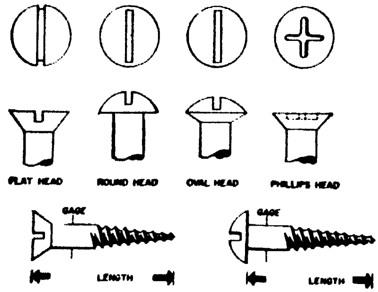
28-4. The eight basic types of joints: (A) edge, (B) butt, (C) rabbet, (D) dado, (E) miter, (F) lap, (G) mortise and tenon, and (H) dovetail. The joints may be strengthened with dowels or with splines.


DOWEL EDGE
TONGUE & GROOVE
A
BUTT ON EDGE
BUTT - FLAT
CORNER BUTT
WITH DOWELS
CORNER BUTT
WITH GLUE BLOCK
B
C
PLAIN DADO
RABBET AND DADO
DOVETAIL DADO
BLIND DADO GAIN
D
FLAT
EDGE
SPLINE FLAT
SPLINE EDGE
DOWEL
E
EDGE-LAP
END-LAP
F
THICKNESS
WIDTH
RAIL
BLIND
BAREFACED
STUB
G
H
LAP DOVETAIL

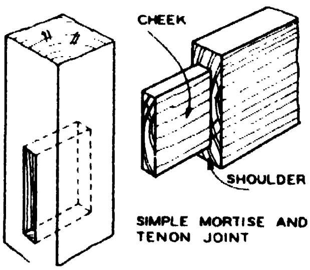
28-4



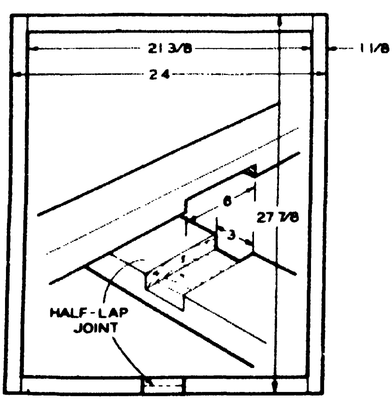
28-5. A miter joint strengthened with two dowels. A note tells the diameter and length.



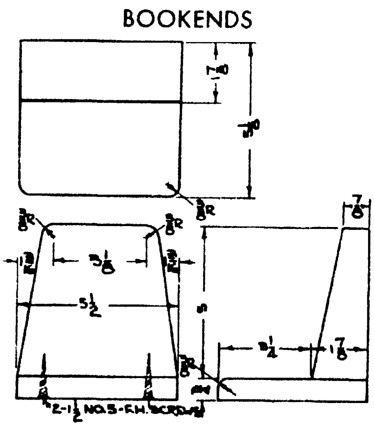
28-8. The common shapes of screws.



28-6. A mortise-and-tenon joint with the mortise shown by invisible lines.



28-7. A detail drawing of a half- or cross-lap joint to illustrate how it is made.

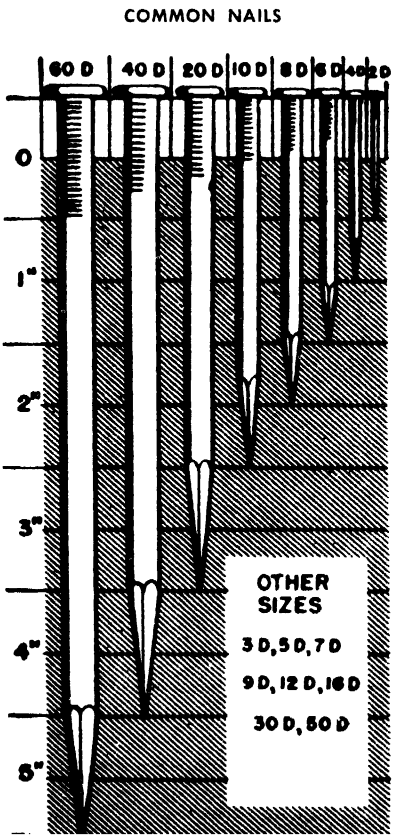


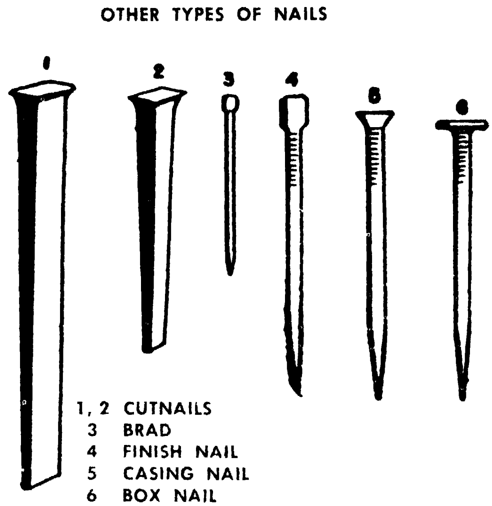
28-9. Notice how the wood screw is shown by invisible lines.

the kind and size of screws are listed in the bill of materials.

Nails. Nails are made in many kinds and sizes. The most common nails are called common, box, casing, and finishing. Fig. 28-10. You may also make use of brads and escutcheon pins for small assemblies. Drawings rarely show the kind or size of nail to use. When they do, it is included as a note. Usually the craftsman is expected to use his own judgment in selecting the nails.

Glue. Glue is usually used in addition to one of the other methods of fastening. The drawing rarely shows where glue is to be used.





28-10. Common types of nails.

WOODWORKING DRAWINGS

The most common drawings used in woodworking are the *working* (view) drawing, *isometric* drawing, and *cabinet* drawing. Drawings for woodworking do not follow the rigid rules you have learned for other work. You can see this for yourself when you compare woodworking and metalworking drawings. Some of the ways in which woodworking drawings vary from other kinds are:

1. The drawing is often a combination of several types. Part of the drawing might be a working (view) drawing while another part might be a perspective or cabinet. Fig. 28-11.

2. If it is a view drawing, the views may not be in proper position. This is especially true if the views are placed on squared paper. The parts are often arranged for the convenience of the page layout rather than standard view placement. Fig. 28-12.

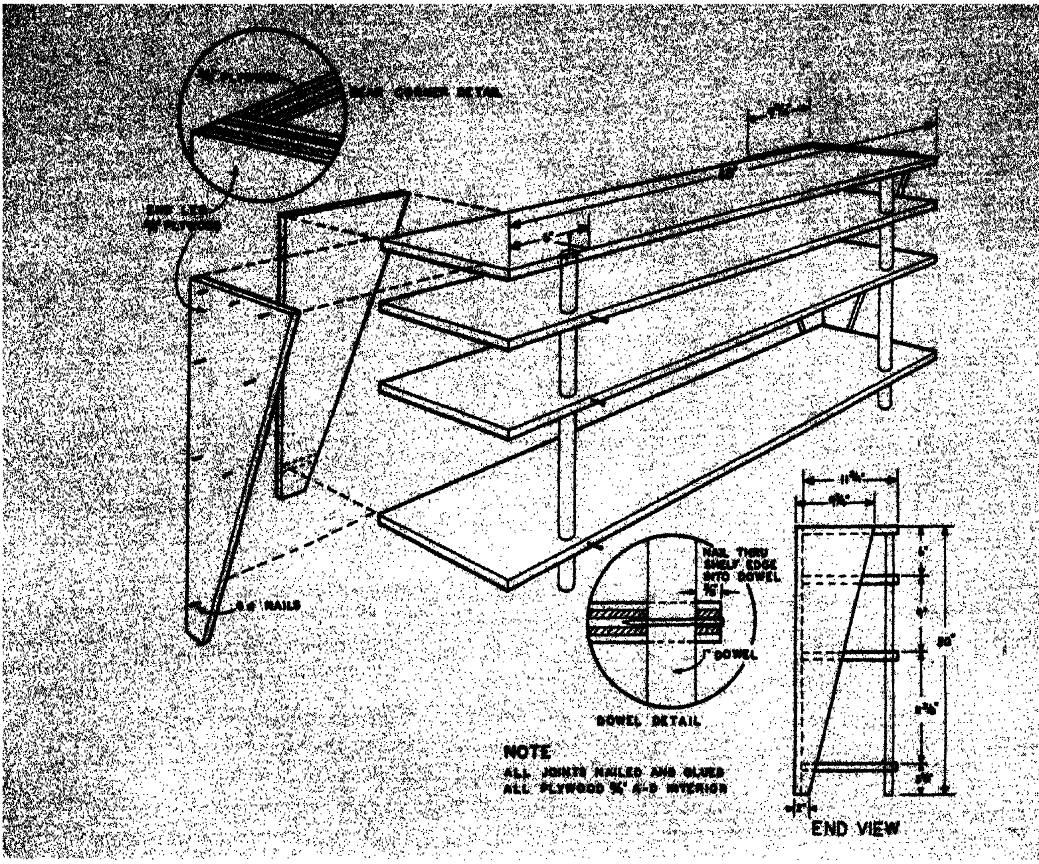
3. The drawing may not be complete in every detail. The craftsman is expected to know how to assemble the project and, therefore, the kind of joints to be used will not be shown.

4. Details are often shown for difficult construction. Sections are used to show the shape of some parts. Fig. 28-13.

5. The inch mark ″ is often shown on all dimensions. Fig. 28-17.

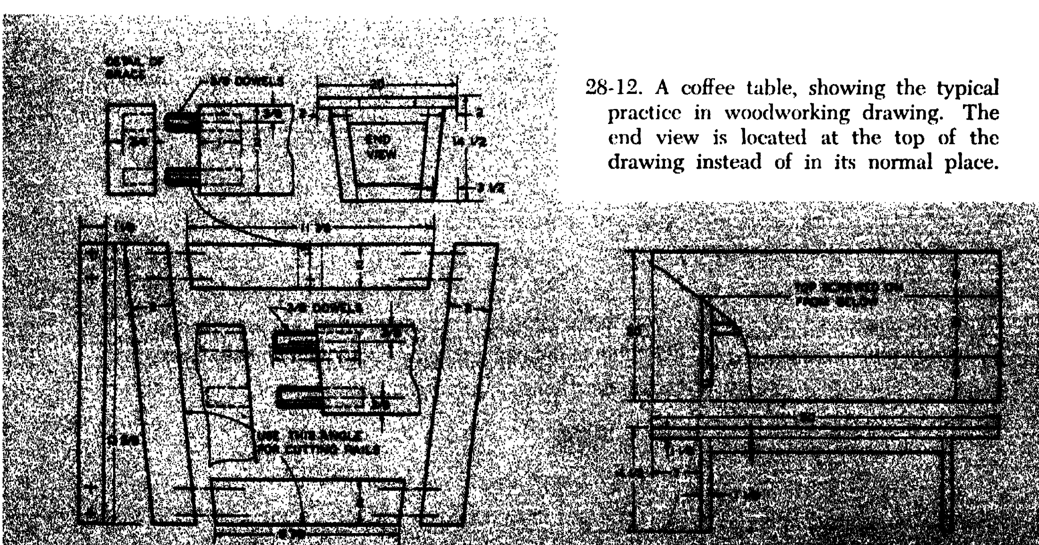
WORKING (VIEW) DRAWINGS

Working (view) drawings are used for many projects. Sometimes the standard three views are shown. Many times, however, only two views are given. Fig. 28-14.

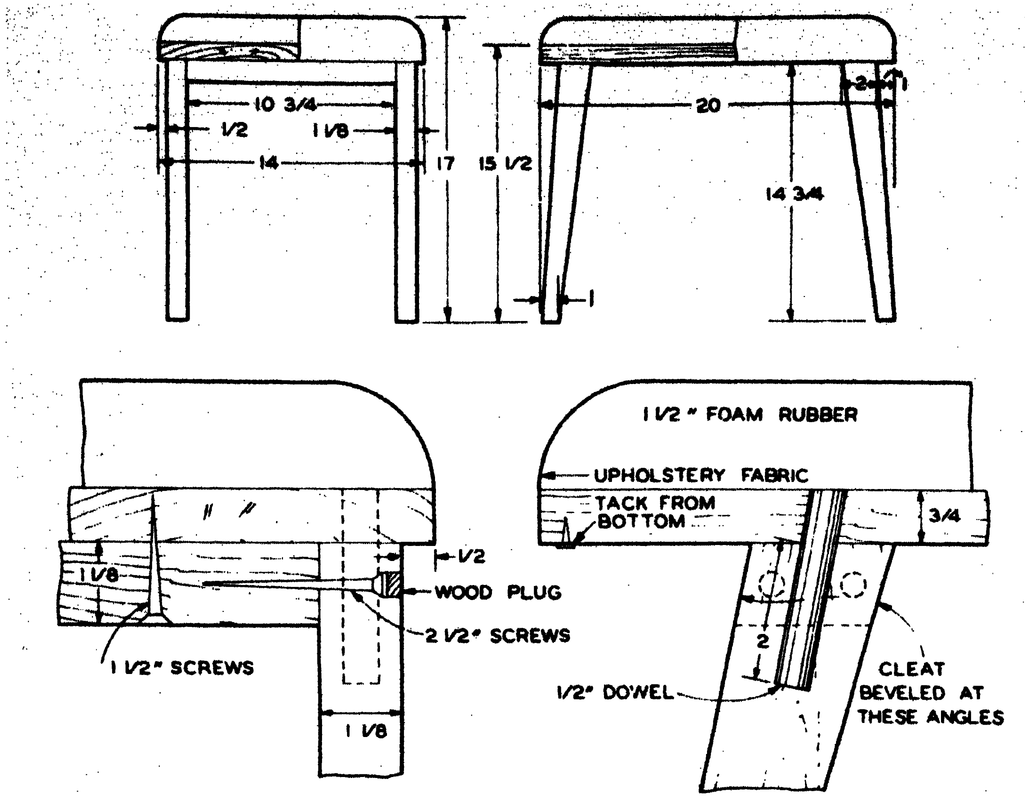


28-11. The use of two different types of drawings on the same illustration. One drawing is in perspective. The end view is a working (view) drawing.

In drawings of turned parts made on a lathe, only two views are needed. Fig. 28-15. The parts are often dimensioned by placing one arrow at



28-12. A coffee table, showing the typical practice in woodworking drawing. The end view is located at the top of the drawing instead of in its normal place.



28-13. Shows details of a vanity stool for construction purposes. Several notes are added to help the craftsman.

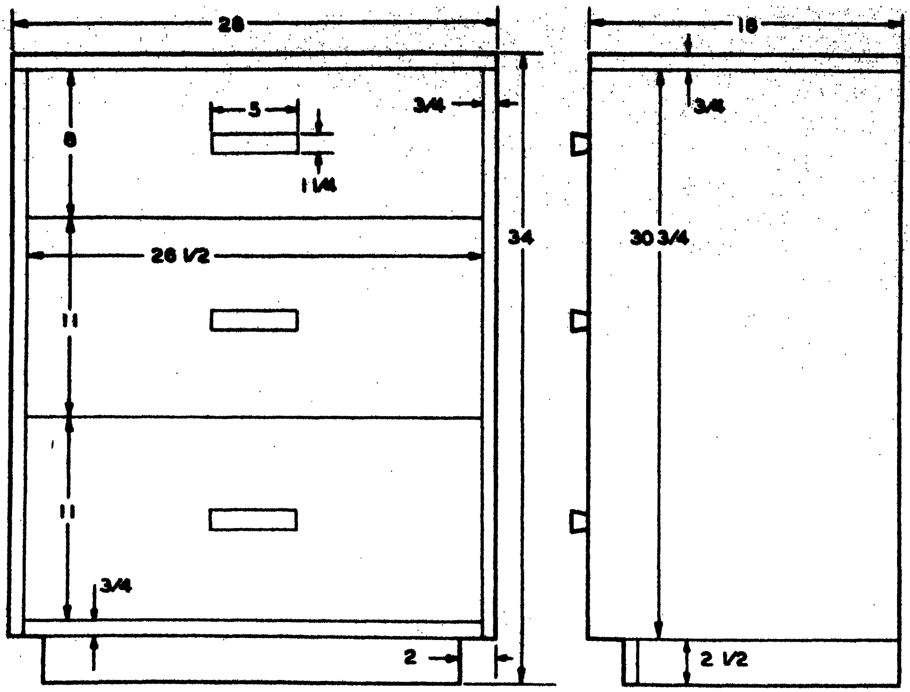
the various diameters or two arrows on opposite sides. Fig. 28-16. The distances between the diameters is also shown. Most working (view) drawings are drawn with the dimensions to be read from the bottom. This is especially true of large furniture drawings since this makes them more convenient to read and easier to use.

CABINET DRAWINGS

The cabinet drawing is the favorite in woodworking. As said before, it gets its name from the fact that it is used a great deal by the cabinet maker, and it is especially good for illustrating rectangular-shaped furniture pieces such as tables, cabinets, and chests. Often a cabinet drawing of a table shows the object with the top removed to show greater construction detail. Fig. 28-17. In addition to the cabinet drawing, there may be several detailed view drawings of parts that are not clear in the main drawing.

ISOMETRIC DRAWINGS

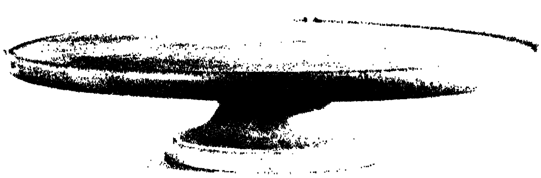
Isometric drawings are used often



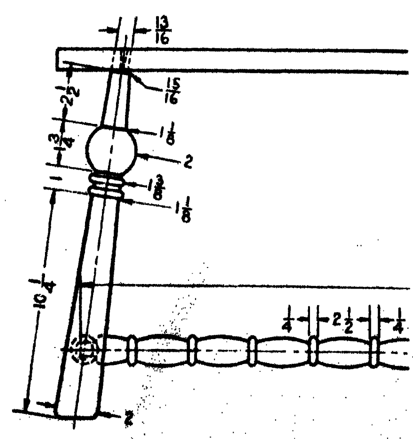
28-14. Most woodworking drawings would have only two views as shown by this dresser.

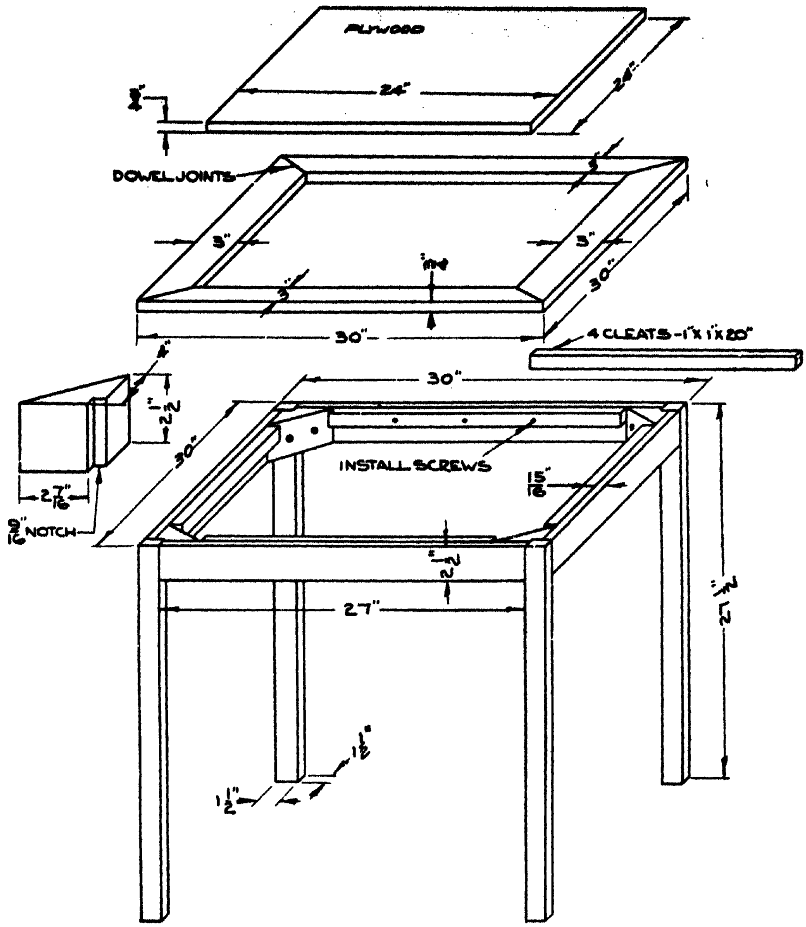
for modern funiture and very simple projects. Fig. 28-18. This type shows how the project will look and gives the dimensions for building it. It is not a good drawing to use for irregularly shaped objects.

28-15. The lazy Susan requires only one or two views.



28-16. The usual method of dimensioning turned parts. Only one arrow is used to show the diameters.





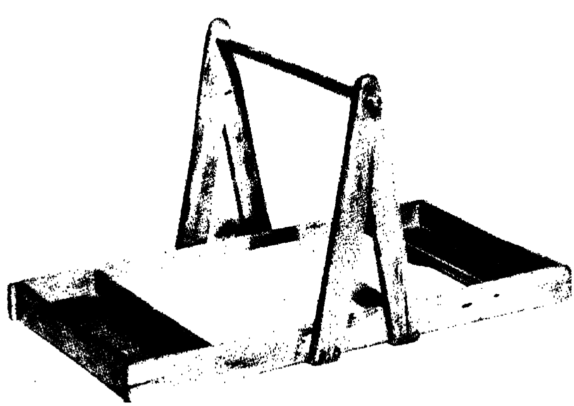
28-17. A good illustration of a cabinet drawing used in woodworking. Notice that the top is removed to show the construction better.

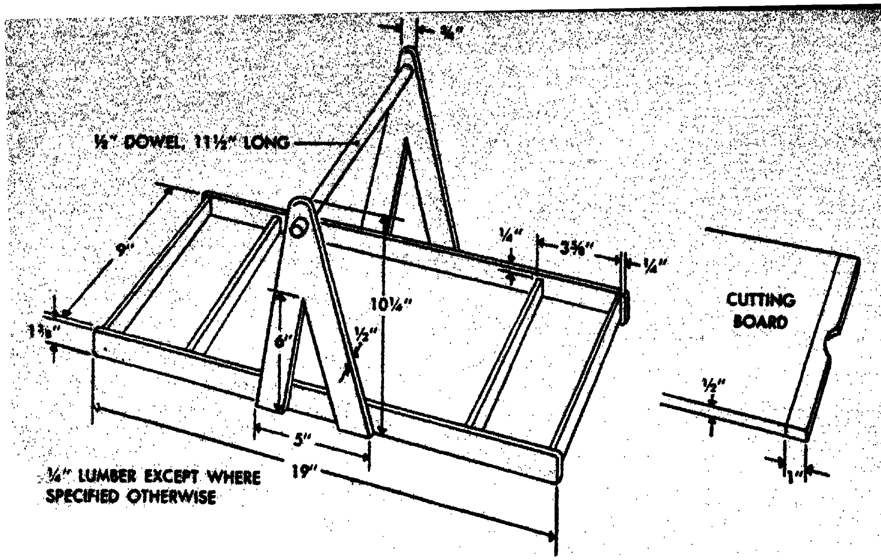
A more common type for modern furniture is the *exploded isometric.* This shows clearly the dimensions of each part and how the parts go together.

MAKING A WORKING DRAWING FROM A PICTURE OR SKETCH

Sometime you may see a picture or sketch of a furniture piece you

28-18A, 28-18B. Many woodworking drawings are made in isometric as is this modern carry-all tray. The cutting board is separate. See page 240.



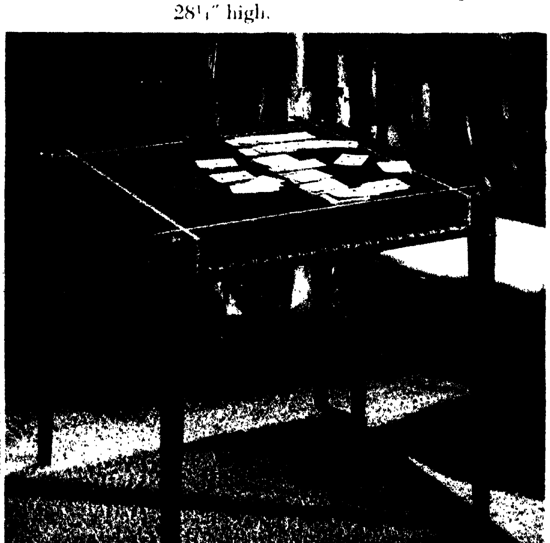


-18B.

would like to make. Fig. 28-19. With careful planning you can design one that is very similar to it, following this procedure:

1. Make a full-size outline of the overall size of the piece. In most cases the width, length, and height will be available. This outline can be made in the same way you would start an orthographic projection, cabinet, or isometric drawing.

28-19. Could you make a drawing of this game table? It's 30" x 30" square and 28¼" high.



2. Determine the approximate scale of the picture or sketch. By measuring the full-size outline and then the actual picture, the approximate scale can be determined. For example, if the overall height of the object is 36" and the height on the picture measures 1½", the scale is about ½" to the foot. This scale can then be followed to determine the approximate size of all major parts. These dimensions will be only approximate; however, the craftsman himself will need to figure out the exact size in order to insure good proportion in the finished piece.

3. Lay out the sizes of each part on the full-size drawing. Decide on the best method of joining the various parts. Remember that there are a great number of different kinds of woodworking joints.

4. Now, "Plan your work; then work your plan".

Section IV

29. Metalworking Drawing

In metalworking you need a drawing or sketch for anything you make. How many things can you think of that are made of metal? Cars, trains, watches, bicycles, bridges, coins, basketball hoops, jewelry, toys. It would be harder to think of things that don't have any metal in them!

Some of the common hand tools used are shown in Fig. 29-1. There are many kinds of metalworking activities. Some of these are:

1. *Bench metal* or *wrought iron* with which common hand tools are used to make simple objects at the bench.
2. *Sheet metal*, which includes the making of objects of thin metal with various cutting, forming, and assembling tools.
3. *Art metal*, which includes the making of jewelry and attractive objects of copper, aluminum, and other non-ferrous metals.
4. *Foundry*, in which metal is melted and poured into molds to make castings.
5. *Machine shop*, in which metal is cut, turned, shaped, and ground with power machines such as the drill press, lathe, shaper, milling machine, and grinder.
6. *Forging*, in which metal is stamped and pounded to shape.
7. *Welding*, which includes assembling metal with gas or electric arc.

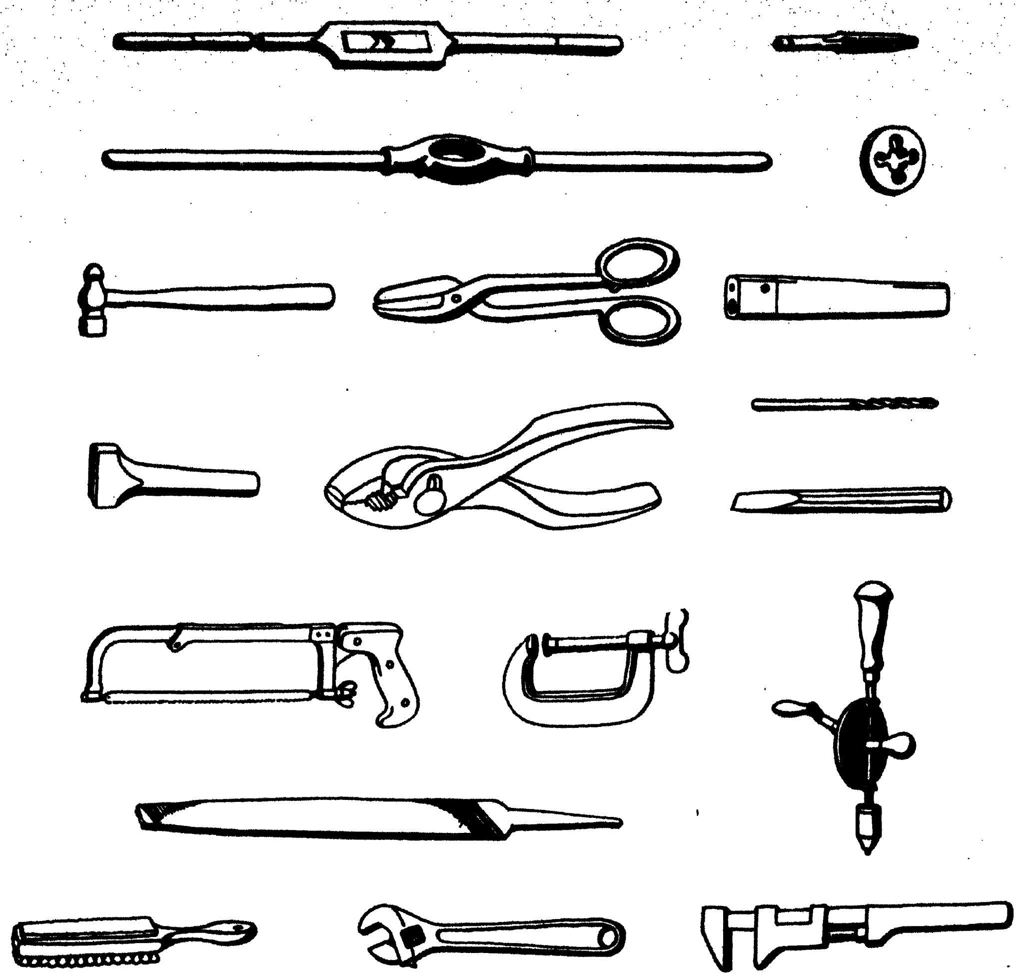
KINDS AND SHAPES OF METAL

All metals can be divided into two groups. Those made from iron are called ferrous metals and those containing no iron, like copper, aluminum, and zinc, are called non-ferrous. Metals are manufactured in thousands of different sizes and shapes. Most of the metal used in sheet metal, art metal, and bench metal is in sheet form. Other common shapes are shown in Fig. 29-2.

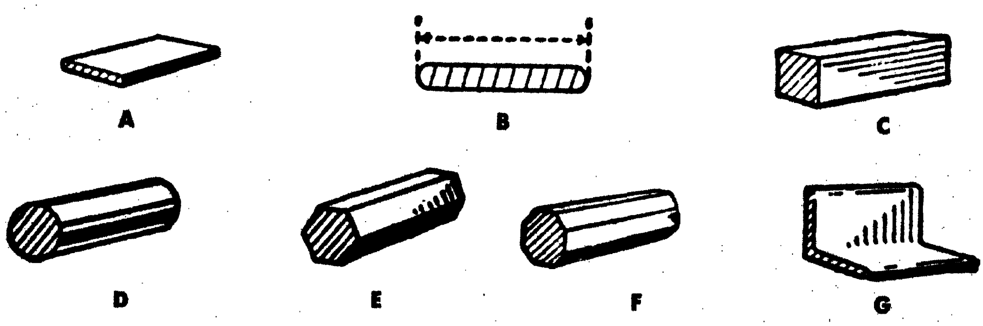
METAL FASTENERS

Metal materials are assembled in many ways. Sheet metal can be held together with seams, solder, rivets or welds. Most things that must be assembled and disassembled such as an automobile engine or a bicycle have threaded fasteners including bolts, nuts, and screws. It is important to know how to show these fasteners on a drawing.

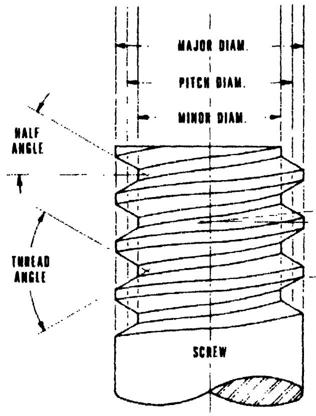
Screw Threads. A *thread* is a V-shaped groove cut around the outside of a rod or inside of a hole. Fig. 29-3.



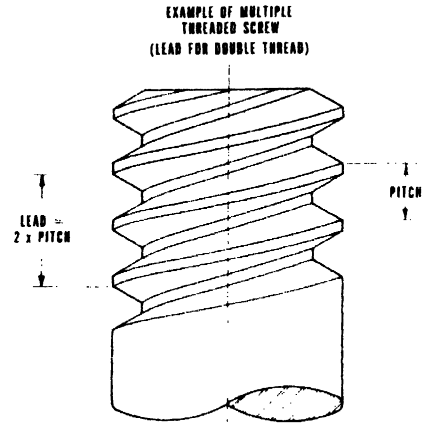
29-1. Could you make a sketch and name these common metal working tools?



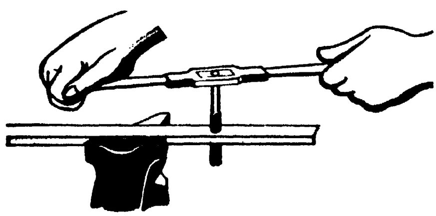
29-2. The common shapes of metal: A. Flat. B. Band. C. Square. D. Round. E. Hexagon. F. Octagon. G. Angle.



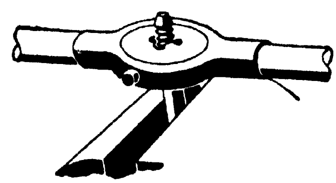
29-3. The major parts of a thread.



29-4. This shows a double thread. The pitch is the distance from the top of one thread to the top of the next thread. The lead is the distance the thread moves in one complete turn. On a single thread, pitch and lead are the same.

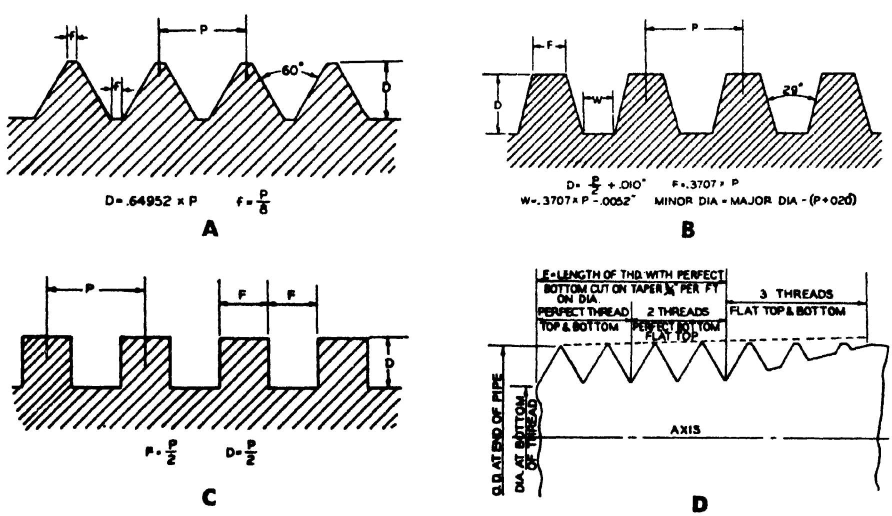


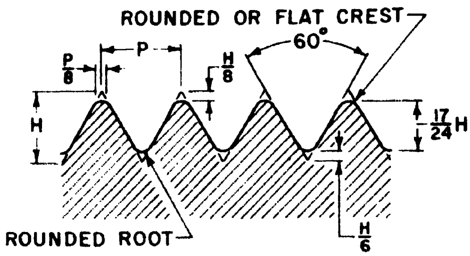
29-5. Cutting an inside thread with a tap.



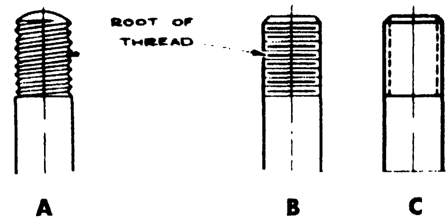
29-6. Cutting an outside thread with a die.

29-7. Four common types of thread form: A. American National. B. Acme. C. Square. D. Pipe thread.





29-8. Unified thread form.



29-10. The three different ways of drawing an external thread. A shows the semi-conventional method. B shows the regular thread symbol. C shows the simplified thread symbol.

National Fine		National Coarse	
Size and thread	Tap drill	Size and thread	Tap drill
4–48	No. 42 (0.0935)	4–40	No. 44 (0.0860)
5–44	No. 37 (0.1040)	5–40	No. 39 (0.0995)
6–40	No. 34 (0.1110)	6–32	No. 36 (0.1065)
8–36	No. 29 (0.1360)	8–32	No. 29 (0.1360)
10–32	No. 22 (0.1570)	10–24	No. 26 (0.1470)
1/4–28	No. 3 (0.2130)	1/4–20	No. 8 (0.1990)
5/16–24	I (0.2720)	5/16–18	F (0.2570)
3/8–24	Q (0.3320)	3/8–16	5/16 (0.3125)
7/16–20	W (0.3860)	7/16–14	U (0.3680)
1/2–20	29/64 (0.4531)	1/2–13	27/64 (0.4219)
9/16–18	33/64 (0.5156)	9/16–12	31/64 (0.4843)
5/8–18	37/64 (0.5781)	5/8–11	17/32 (0.5312)
3/4–16	11/16 (0.6875)	3/4–10	21/32 (0.6562)
7/8–14	13/16 (0.8125)	7/8–9	49/64 (0.7656)
1–14	15/16 (0.9375)	1–8	7/8 (0.875)

29-9. The number of threads per inch for each size of thread.

Threads are used for fastening, for adjusting and for transmitting power. Fig. 29-4. In bench work, inside threads are cut with a *tap* and outside threads with a *die*. Fig. 29-5. Fig. 29-6. In machine shop, threads are cut on many kinds of machines including the lathe and drill press.

1. Thread form. There are four common thread forms used in the United States: American National, Acme, Square, and Pipe thread. Fig. 29-7. By far the most common for most assembly is the American National. This is a 60-degree, V-shaped thread. The top, or crest, and the bottom, or root, of the V both have a small, flat surface.

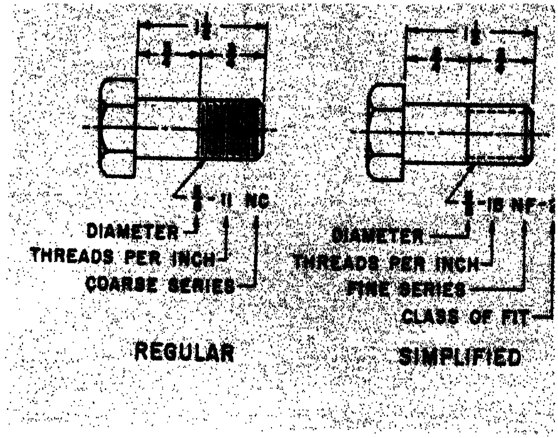
The United States, Britain, and Canada have agreed on a thread form called the "Unified form." It has a 60-degree angle and is the same as

the American National except that on the external thread the root is rounded and the top or crest may be either flat or rounded. Fig. 29-8. Because these forms are so similar in shape, a nut of one will fit over the threaded bolt or rod of the other.

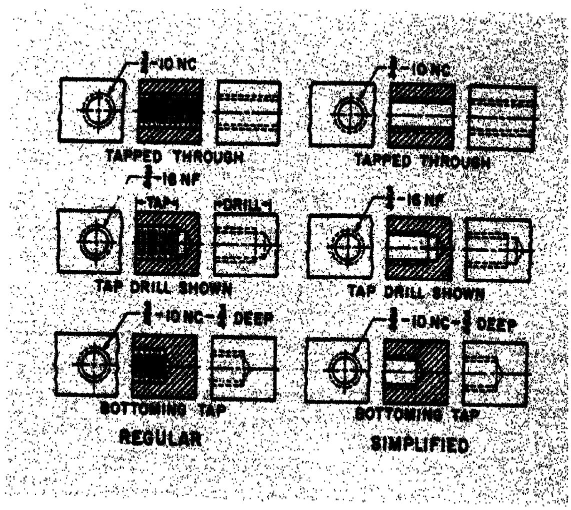
2. Series. American National and Unified forms are made in several series. The two most common are the National Coarse (NC) and the National Fine (NF). The only difference between the two series is the number of threads per inch. Fig. 29-9. For example, a ½″ NC has 13 threads to the inch and a ½″ NF has 20 threads to the inch. Below ¼″, threads are measured by the gauge of wire they are made from and the number of threads per inch. For example, 8-32 means wire gauge No. 8 and 32 threads to the inch.

3. Classes of fit. Threads are manufactured in different classes of fit. The fits are No. 1—loose fit, No. 2—free fit, No. 3—close fit, and No. 4—snug fit. *Fits are not generally shown on school-shop drawings.* Most ordinary threaded fasteners are made with a free, or No. 2 fit.

4. Drawing screw threads. It would be difficult and time consuming to make a picture drawing of threads. It wouldn't be of much use either because all it tells is that it is a thread. Therefore symbols for screw threads are used on all drawings. There are two types of symbols, *regular* and *simplified.* In the regular symbols, the external or outside thread is shown as in Fig. 29-10B, with a long, light line and a short,

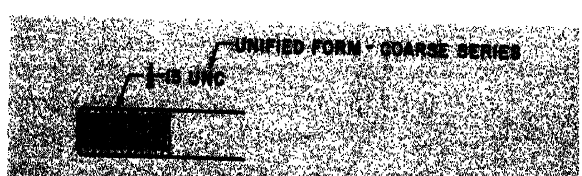


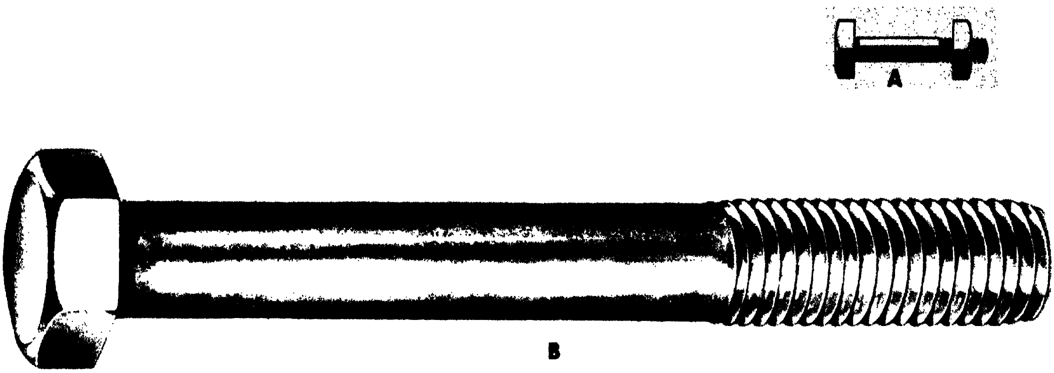
29-11. The important information about the cap screw is shown in the note. Sometimes, in addition to diameter, number of threads per inch and the series, the class of fit is also shown.



29-12. The correct symbols for internal threads. Either method is correct.

29-13. The correct way to show a Unified thread.





29-14. A (a) square and a (b) hexagonal machine bolt.

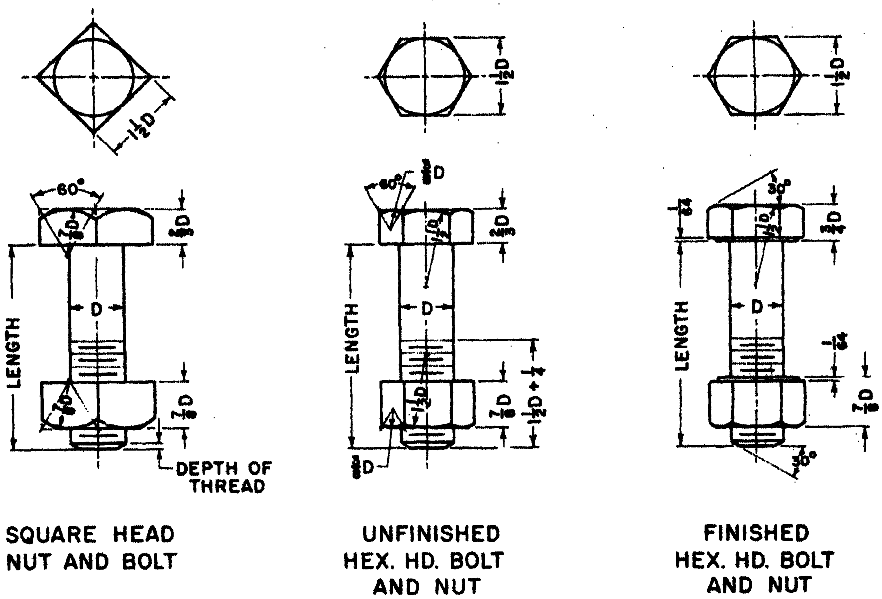
heavy line alternating. The long line represents the crest of the thread and the short line the root. These should be spaced to look well to the eye, about 1/32" to 1/16" apart. The end of the thread is usually chamfered (cut off at an angle) at 45 degrees. An even quicker way to draw external threads is shown in Fig. 29-10C. This is the *simplified* thread symbol. Either is correct and can be used on all drawings. Remember, however, that these symbols show only that there is a threaded portion on the rod, bolt, or screw. A dimension is needed to show the length of the thread. The important information about the thread is given in a note. Fig. 29-11. This includes diameter, number of threads per inch and the series. The class of fit can be added. Fig. 29-11.

Threads are always *right-handed* unless shown otherwise. If the threads are *left-handed*, the letters LH should be added. Fig. 29-12 shows the symbol for a tapped hole. Looking down on the tapped hole, the thread is shown by a circle of solid line on the inside and a circle of invisible, or hidden, lines just outside this. The note tells the diameter, number of threads per inch, and the series. Sometimes the tap-drill size is included in the note. Fig. 29-12 shows the simplified thread symbols for a tapped hole. A Unified thread form would be shown as in Fig. 29-13.

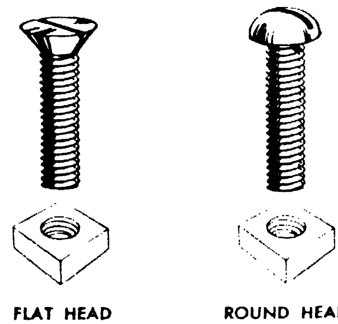
5. Threaded metal fasteners. There are hundreds of different threaded fasteners, many of which are for special uses. Here are only a few of the more common ones you should know:

a. *Machine bolts* and *nuts* are made in diameters from 1/4" to 1 1/4" and lengths from 1/2" to 24". There are three qualities of machine bolts,—the unfinished, the semi-finished, and the finished. They are manufactured as *regular* for most work or as *heavy* for great, massive surfaces. They are available in either square or hexagonal-shaped heads. Fig. 29-14. Machine bolts are used for all types of assembly work. Fig. 29-15. The size needed is shown on the drawing or in the bill of

*For complete specifications on "Square and Hexagon Bolts and Nuts," secure the bulletin ASA B 18.2-1952. For specifications on "Slotted and Recessed Head Screws," secure the bulletin ASA B 18.6-1947. Both are available from the American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N.Y.

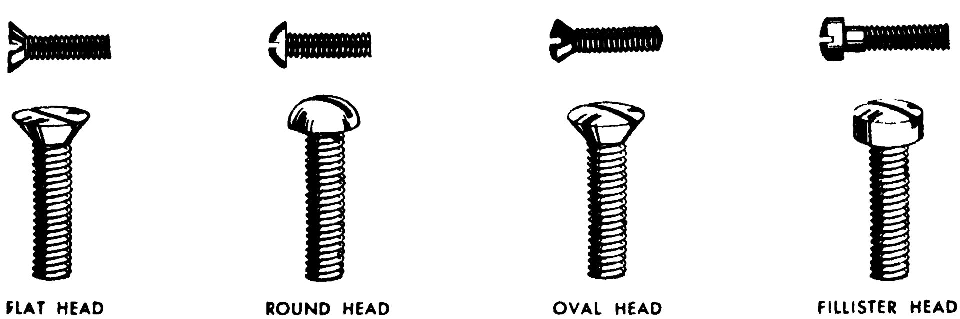


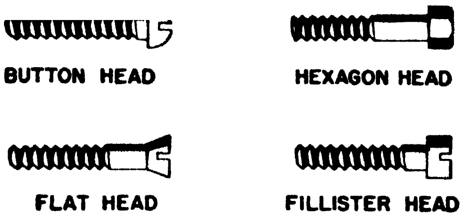
29-15. Information on how to draw American National bolts.



29-16. Stove bolts

29-17. Machine screws





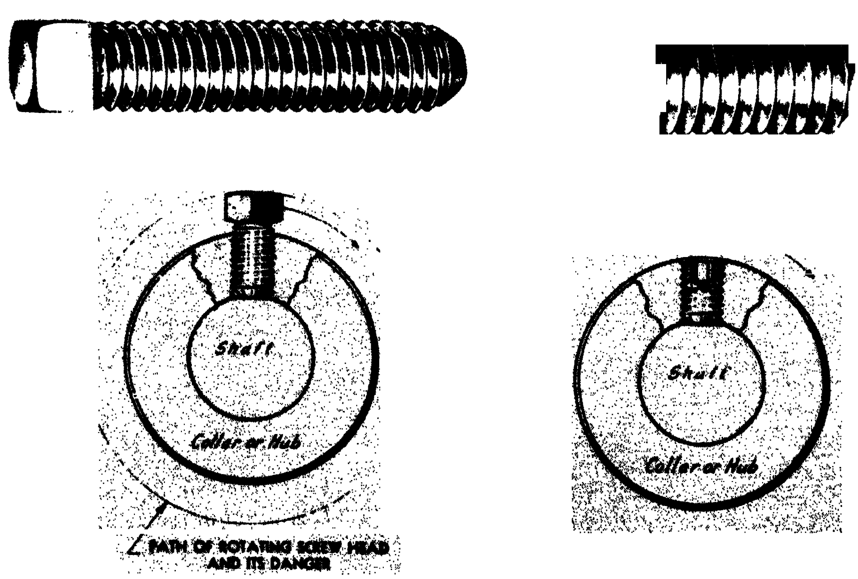
29-18. Cap screws.

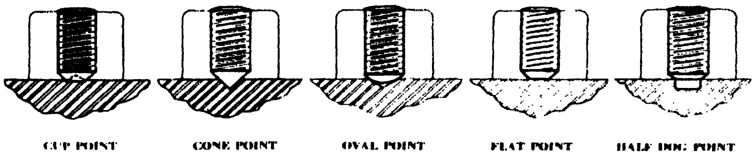
materials as follows: ½-13 NC Fin. Hex. Hd. Bolt x 2¼" Lg. This means: ½" in diameter, 13 threads to the inch, National Coarse, a finished bolt with hexagonal head 2¼" long.

b. *Stove bolts* are made with flat or round heads. They come in diameters from ⅛" to ½" and in lengths from ⅜" to 6". Square nuts are supplied with the bolts since the thread is a National Coarse thread series. Stove bolts are used for assembly of sheet-metal parts. Order as follows: 3/16" Flat Hd. Stove Bolt 2" Lg. Fig. 29-16. This means that the stove bolt is 3/16" in diameter, has a flat head and is 2" long.*

c. *Machine screws* are made with flat, round, fillister, and oval heads. Fig. 29-17. They come with either a slotted or a recessed head. They are used for fastening two pieces of metal together when the second part has a tapped hole. These screws are made of steel or brass and are threaded along their entire length. Nuts are not furnished with machine screws, although square or hexagonal nuts can be purchased. Machine screws are available in National Coarse (NC) or National Fine (NF). Under ¼" in diameter, the size is shown by the American Screw Wire Gauge (from 2 to 12) and

29-19. Set screws used to hold a shaft from turning.





29-20. Examples of set screw points.

the number of threads per inch. For example, number 6-32 NC means that the wire gauge is number 6 and there are 32 threads per inch. Machine screws are used for assembling small mechanical and electrical projects. The size is shown on a drawing as follows: No. 8-32 NC x 1″ RD Mach. Screw Brass.

d. *Cap screws* are much like machine screws except that they are larger. Fig. 29-18. Except on the smaller size, the threads run only a part of their length. Their sizes range from ½″ to 1″ in diameter, from ⅜″ to 6″ in length. They come in five standard heads. They are used like machine screws to assemble two parts, the second of which has a tapped hole. A note on the drawing should give the diameter, threads per inch, series, length, and type of head.

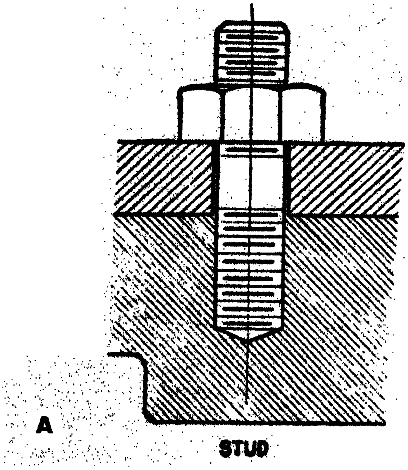
e. *Set screws* hold two parts together to prevent one part from turning. For example, they are used to hold a pulley on a shaft. Fig. 29-19. Some of the common shapes of points are shown in Fig. 29-20.

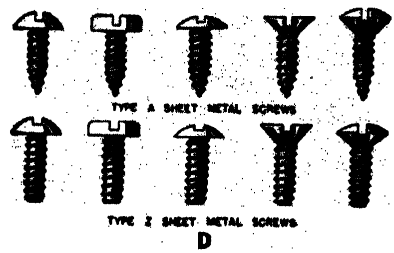
f. Other threaded fasteners include the *stud, carriage bolt, lag screw,* and *self-tapping sheet-metal screws.* Fig. 29-21. Some of the common nuts and washers are shown in Fig. 29-22.

6. *Rivets* used in the school shop are of two kinds. Rivets for assembling bench-metal and art-metal projects are made with heads as shown in Fig. 29-23. They are made of soft carbon steel, aluminum, copper, or brass. A note on the drawing should show the diameter, the length, the kind of head, and the kind of metal. For example: 3/16″ x 1″ R.H. Copper. *Tinners' rivets* are made of mild steel with black iron-oxide coating or with galvanized coating. Fig. 29-24. The size is shown by the *weight per thousand.* For example, 1,000 8-ounce rivets weigh 8 ounces. The size of rivet to choose is shown by a note on the drawing.

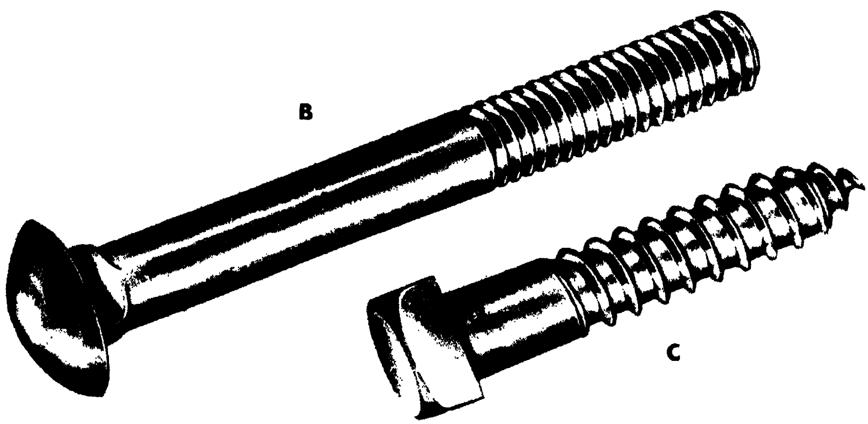
BENCH METAL, OR WROUGHT IRON, AND ALUMINUM

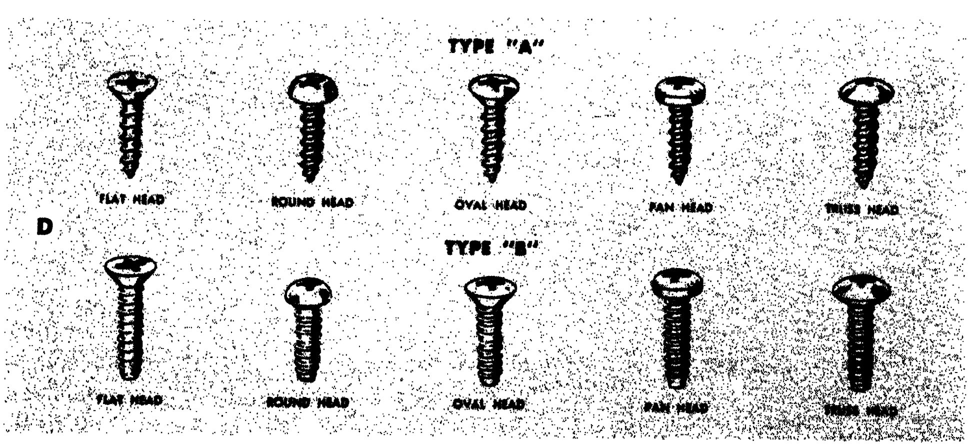
Most bench-metal, or wrought iron, and aluminum projects are made of mild steel or aluminum. Fig. 29-25. The drawing may show one, two, or three views. Often there is an assembly drawing of the whole project and a pattern drawing of the parts. The drawing usually includes several notes, giving information about materials and construction. Fig. 29-26.

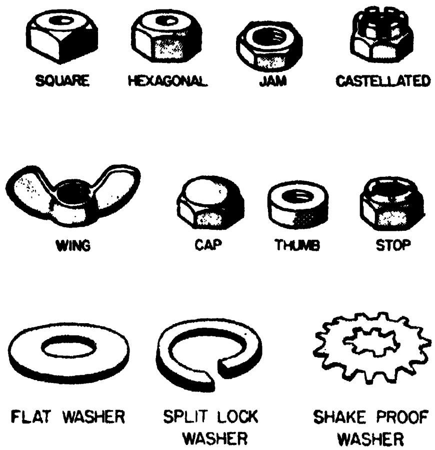




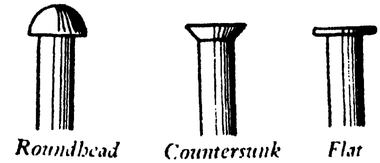
29-21. Other types of bolts and screws and self-tapping sheet-metal screws: A. Stud. B. Carriage bolt. C. Lag screw. D. Sheet-metal screws.



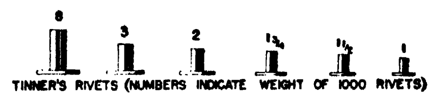




29-22. Common types of nuts and washers.



29-23. Rivets for heavy metal.



29-24. Sheet-metal rivets.

SHEET METAL

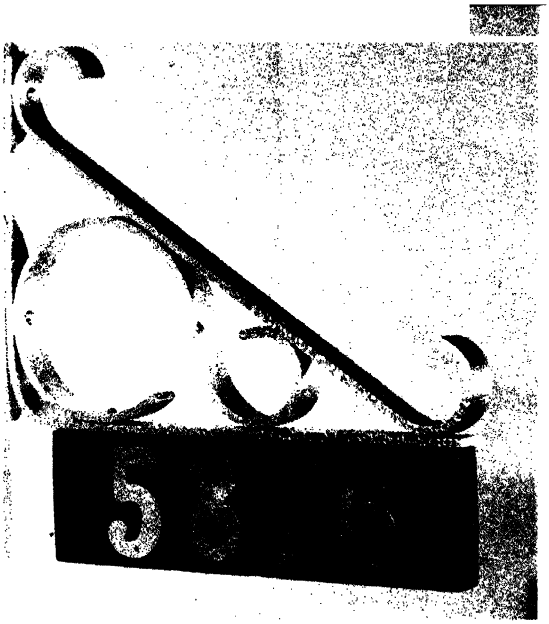
Before any sheet-metal project can be made, a full-size pattern is needed. Fig. 29-27. The method of making this pattern is called pattern development, or making a stretchout. What you do is make a full-size flat pattern of the object. This can then be bent or formed to shape. The pattern may be drawn directly on the metal but, more often, it is first developed on a piece of paper. If the pattern is drawn on paper, it is later transferred to the metal. This is done by placing the paper pattern directly over the metal and prick-punching around the outline.

Before making a sheet-metal pattern you should become acquainted with the following:

Drawing Practice. Patterns must be made accurately to size and shape, but the appearance of the drawing is not important. Often the pattern will be made on wrapping paper if it is large. Sometimes the pattern is not dimensioned because it is full size.

There are four lines commonly used in sheet-metal drawing. The *visible,* or *object line,* shows the overall shape and size of the pattern. The *center* line shows the center of the pattern. The *bend* line shows where the metal is bent. This is usually drawn as a light, solid line. Sometimes small x's are placed near the end of the line. In some drawings the bend line is shown by long dashes. *Projection* lines are drawn either as light, solid lines or as long dashes. Fig. 29-34. These are used only in developing the pattern. The corners of the material for seams, hems and wired edges are notched (cut off at an angle of 45 degrees). Fig. 29-32. This is done to avoid too much overlapping of materials.

Metals. The materials most commonly used are galvanized iron, tin plate and aluminum. Tin plate is used to make kitchen items. It comes

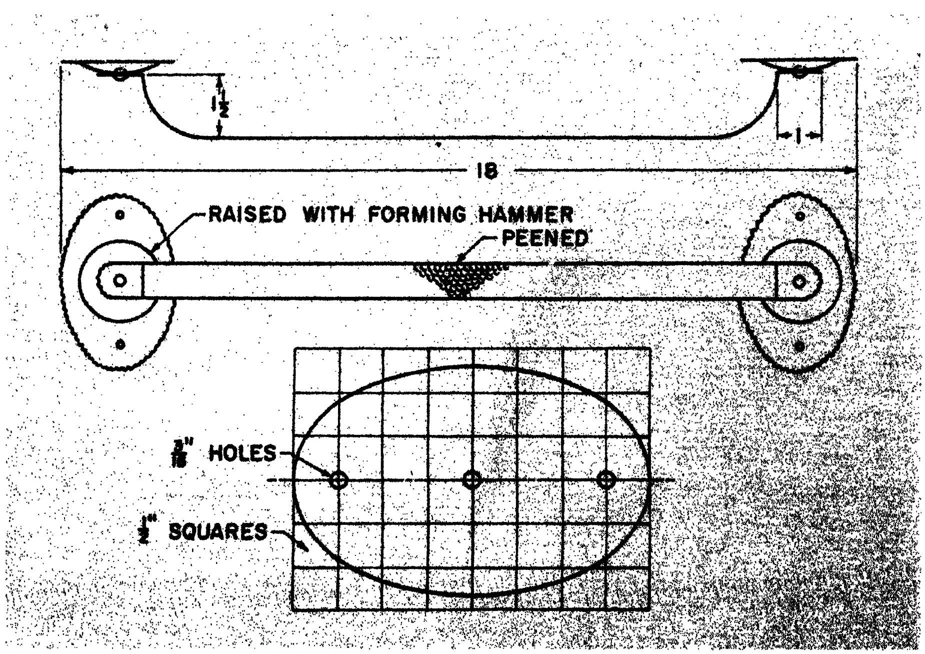


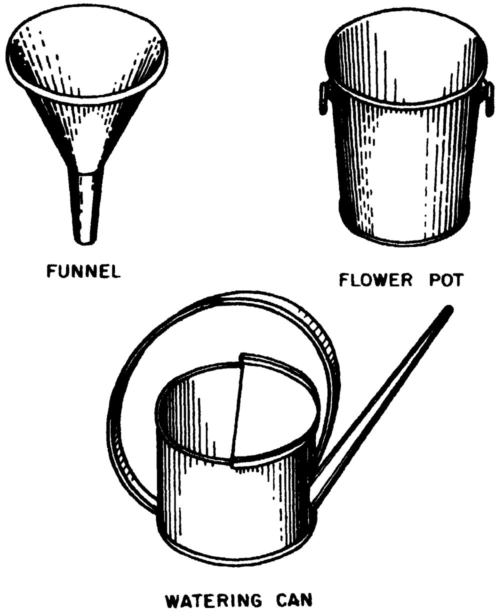
-25. A typical bench-metal project made of wrought aluminum.

in various thicknesses. The most common are IC and IX. The sheets are 20" x 28". Aluminum and galvanized iron are used for other kinds of projects such as funnels, wastepaper baskets and lamps. Common thicknesses of galvanized iron are No. 28 to 26 gauge for small projects and No. 22 to 20 for larger projects.

Seams. The common seams for joining sheet metal are shown in Fig. 29-28. The *lap* seam is usually riveted and/or soldered. The *folded* and *grooved* seams are very similar in construction. There are three thicknesses of metal for the seam above where the two pieces join. For a ¼" grooved seam, an allowance of ¾" extra metal must be made. On a drawing, half this amount (⅜") is

29-26. Bench-metal tie rack.





29-27. Patterns are needed for sheet-metal projects like this one.

added to either side or end. A note should indicate the kind of seam to use.

Hems. A hem is a folded edge which stiffens and strengthens the object. Fig. 29-29. It may be either a single or a double hem. Hems are made in standard fractions such as ¼", ⅜", etc. A note should indicate the amount.

Wire Edge. A wire may be added to strengthen the edge of sheet metal. Wire is measured by the American Wire Gauge. A No. 10 wire, for example, is slightly larger than ⅛" in diameter. Fig. 29-30. On a pattern, material is added equal in amount to 2½ times the diameter of the wire. A note should tell the size of the wire.

Kinds of Patterns. There are four kinds of pattern development: Fig. 29-31.

1. *Angular* for objects that are square or rectangular such as boxes, trays and containers.

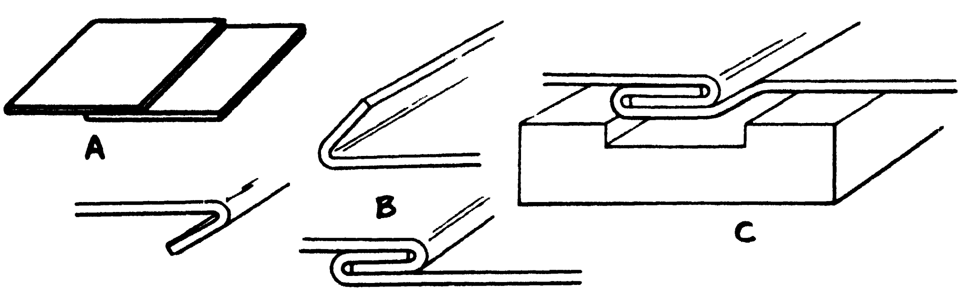
2. *Cylindrical, or parallel line,* for objects such as cans, tubes, pipes, and scoops.

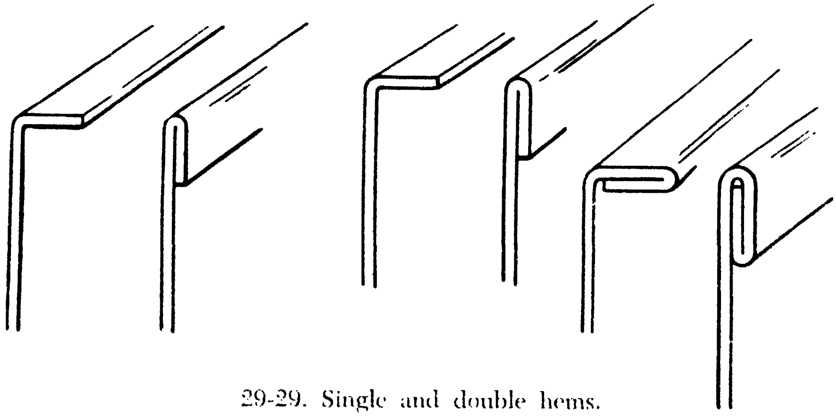
3. *Cone, or radial line,* for objects that are cone- or prism-shaped, such as funnels, buckets, tapered lamp shades, or post lamps.

4. *Transition,* or *triangulation,* for objects that change in shape and size, such as fittings for furnaces or air-conditioning systems.

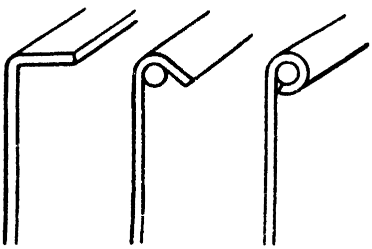
You will need to do pattern development for all types of sheet-metal projects. The sheet-metal worker in

29-28. The lap (A), folded (B), and grooved (C) seams.



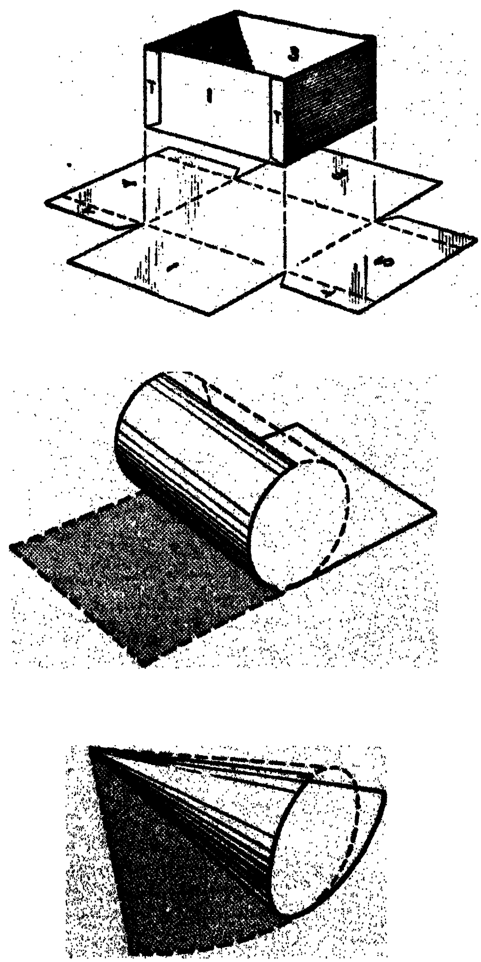


29-29. Single and double hems.



29-30. Wired edge.

29-31. Three basic kinds of patterns: angular, cylindrical and cone shapes.



industry makes use of pattern development for pipes and duct work for heating, air conditioning and other types of sheet work.

HOW TO MAKE PATTERNS

1. Angular. Boxes, containers and other simple layouts are usually drawn directly on the metal. Fig. 29-32. To lay out a box, first draw a square or rectangle equal to the size of the bottom. Then draw the sides. Add material for the hem and seams.

2. Cylindrical. To develop a pattern for a cylinder or the sides of a can, proceed as follows:

a. Make a two-view drawing of the can, showing the front and top.

b. Divide the top into several

equal spaces, usually 12. This can be done with your triangles as shown in Unit 4, Section I.

c. To the right of the front view draw a stretchout as shown in Fig. 29-33.

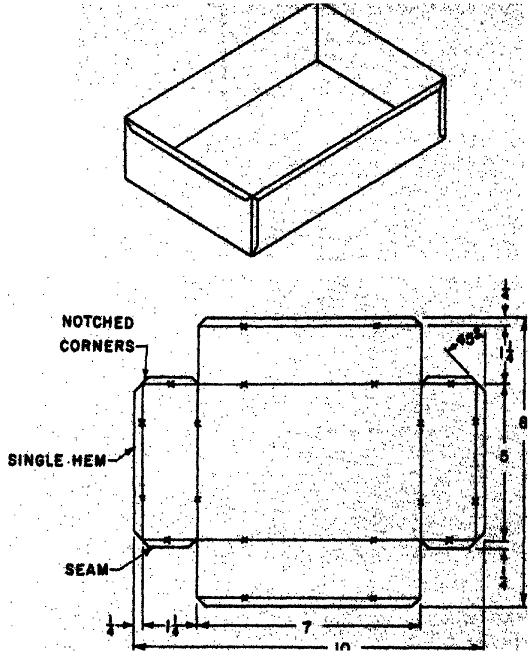
d. Set your dividers equal to one of the spaces on the top view. Space off the required number on the stretchout. To check for the correct number of spaces, number the lines on both the top view and the stretchout. Add an amount on the end for a seam.

e. The circumference can be found by multiplying the diameter by 3.1416.

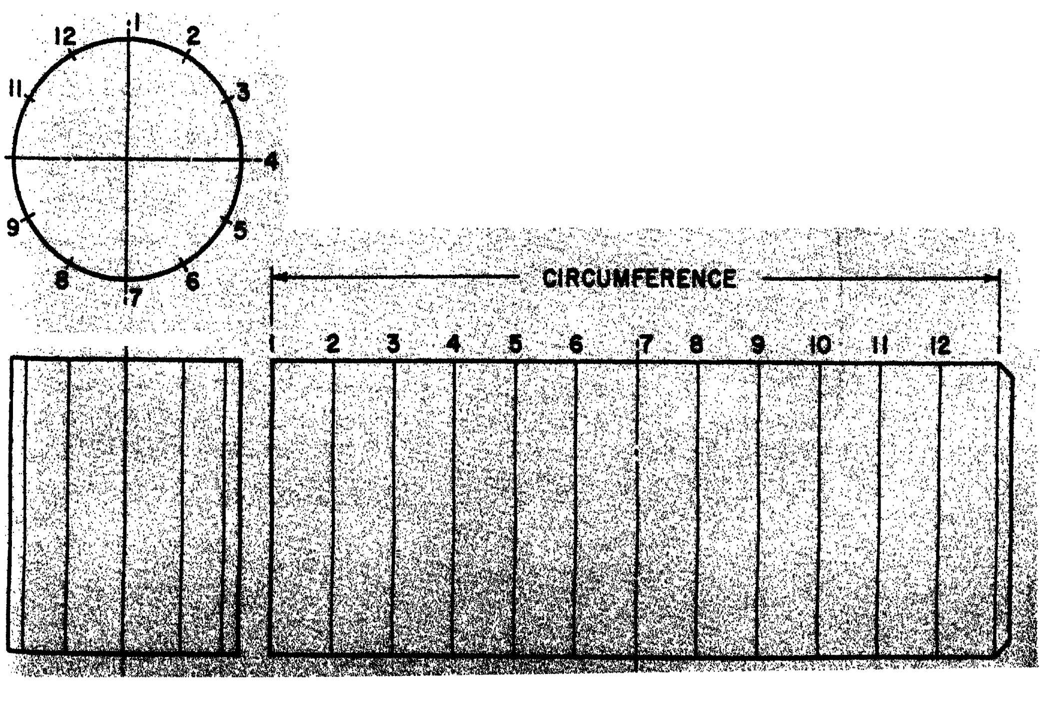
To make a pattern for a sugar scoop or any other object on which one end is shaped, proceed as follows:

a. Make a two-view drawing of the scoop: Fig. 29-34.

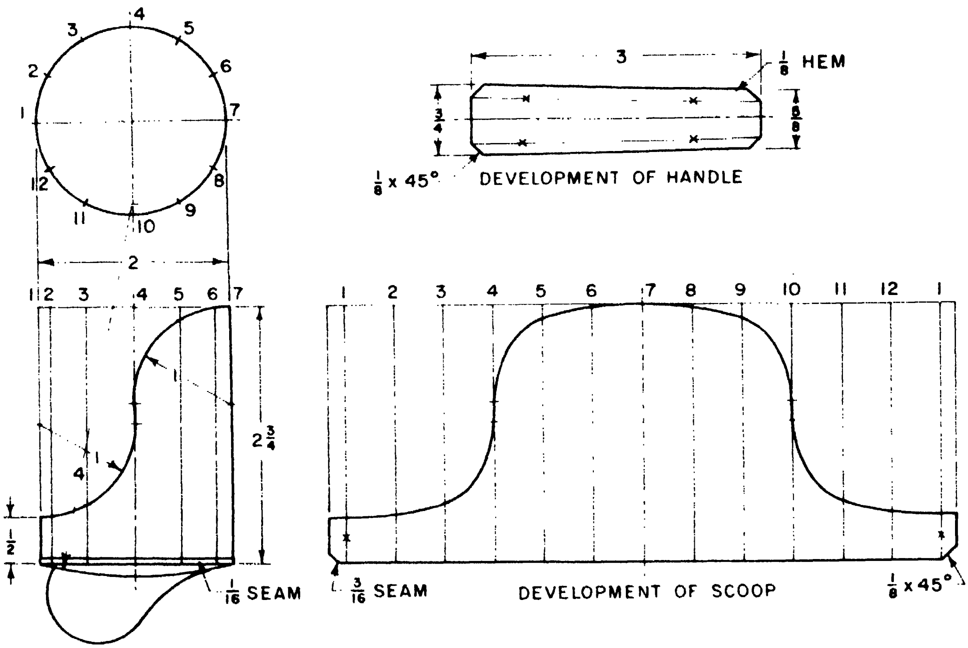
b. Divide the top view into several equal parts (12 or more). The more parts, the more accurate the



29-32. A pattern for a sheet-metal box.



29-33. Pattern for a cylinder. This is how it is developed.



29-34. A pattern for a scoop.

stretchout will be.

c. Draw light vertical lines from the top view to intersect the front view. Number these lines.

d. Make a stretchout to the right of the front view. Draw light vertical lines on the stretchout and number them the same as the front and top view.

e. Locate line 1 on the front view and project this to line 1 on the stretchout. Do this for all the other lines—2, 3, 4, etc.

f. Join these lines with a French curve. This will be the flat-pattern layout for the scoop.

g. This same method can be followed for making a stretchout of pipe intersections.

3. Cone or radial line. Cone- or radial-line development is used for making patterns for funnels, buckets, and other cone-shaped objects. The outline of an ordinary *ice-cream cone* rolled on a flat surface shows the pattern of a cone. To make this pattern proceed as follows: Fig. 29-35.

a. Draw a triangle ABC equal to the shape of the cone.

b. Draw a semicircle BC at the end of the cone.

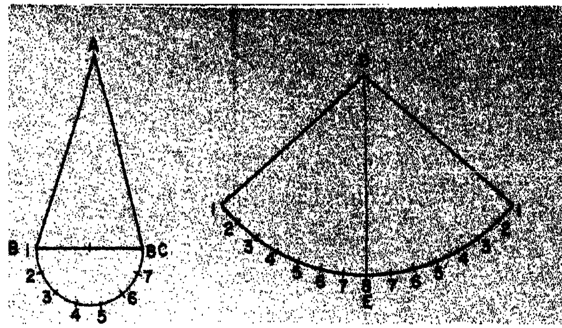
c. Using AB as a radius strike an arc for the stretchout, or flat pattern. Draw a straight line from one end of the arc to the center.

d. Set the dividers equal to one of the spaces. Lay off the number of spaces along the arc (twice the spaces of the semicircle). Join the other end of the arc with the center to form the flat pattern of the cone.

e. A pattern for a funnel is made

in the same way except that the end of the cone is cut off. Fig. 29-36. Draw a front view of the funnel. Continue the lines that show the tapered sides of the body until they intersect. To develop the pattern, two arcs must be drawn to show the inside and outside of the stretchout. A layout must be made both for the body and for the spout of the funnel. Add material for the seam and wire edge. There is a simple mechanical way of making a pattern for an object like a funnel:

(1) Draw a front view of the funnel body.



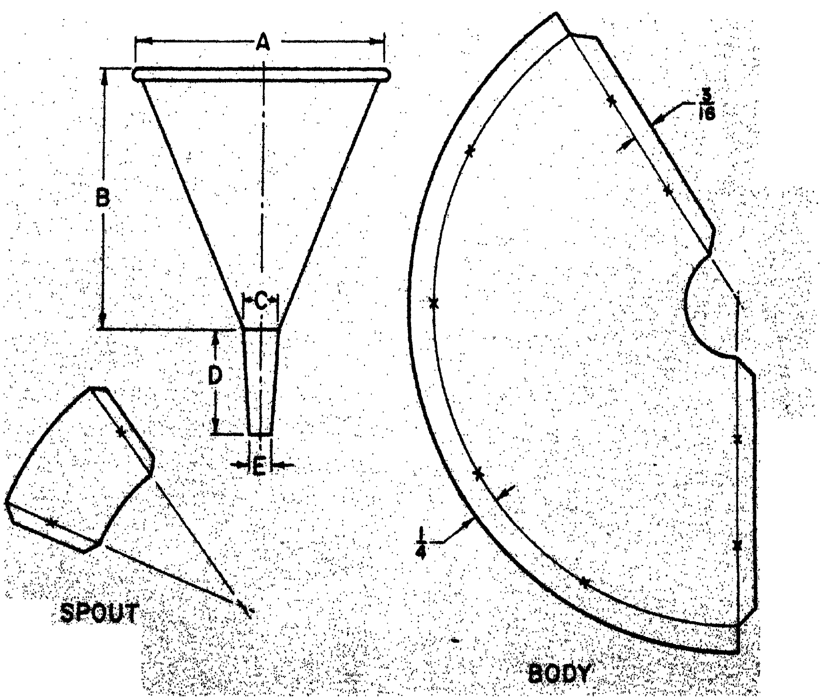
29-35. Making a flat pattern for a cone-shaped object.

(2) Draw a half circle at either end.

(3) Place this paper pattern on metal and cut to shape.

(4) Bend the semicircular ends at right angles. Rub chalk on the round edges. Fig. 29-37. Use a piece of black paper. Place the

29-36. Can you develop a pattern for this funnel? This is called a pattern for a frustum of a cone.



metal template on the paper and roll the template from one side to the other. Move the template and repeat. You will have the pattern for the body of the funnel. Sheet-metal workers use this method for many layouts.

Make a pattern for a pyramid. A pyramid shape is found in a lamp shade or wastepaper basket with tapered sides.

(1) Draw a front and a bottom view of the pyramid. Fig. 29-38.

(2) Using AX as a radius, draw a stretchout arc. Join the center and one end of the arc.

(3) Set the dividers equal to the length of one side of the prism, AB on the bottom view. Lay off the four sides along the stretchout arc.

(4) Join these points to form the four triangles.

4. Triangulation, or transition. This is used primarily by the sheet-metal worker. Transition of a square to a round is shown in Fig. 29-39.

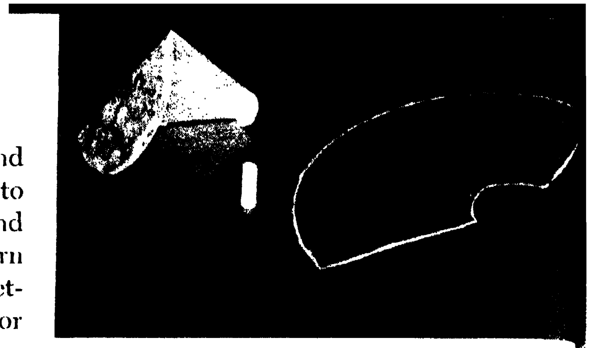
ART METAL

Projects in art metal are made of copper, brass, aluminum, and other non-ferrous metals. There are at least three common types of projects:

1. Flat objects such as pictures, plaques, pins and other simple shapes. A pattern drawing is needed for the shape of the object. For surface decoration a design drawing is needed. Fig. 29-40.

2. Trays and bowls that require a simple two-view drawing. Fig. 29-41.

3. Boxes, lamps, and containers which require a pattern like that used in sheet metal.

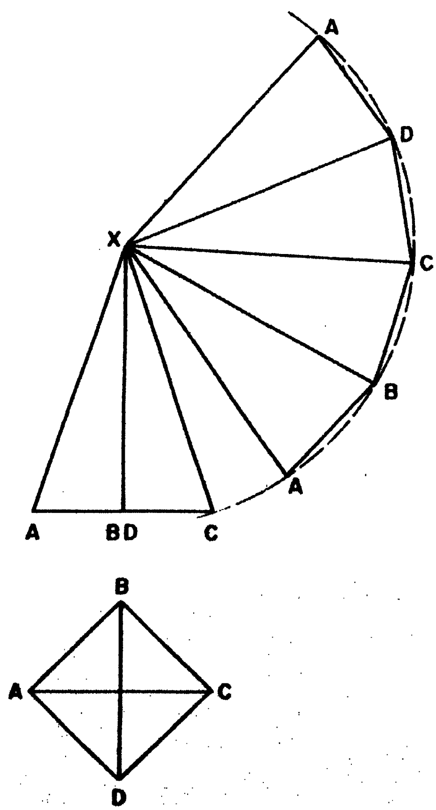


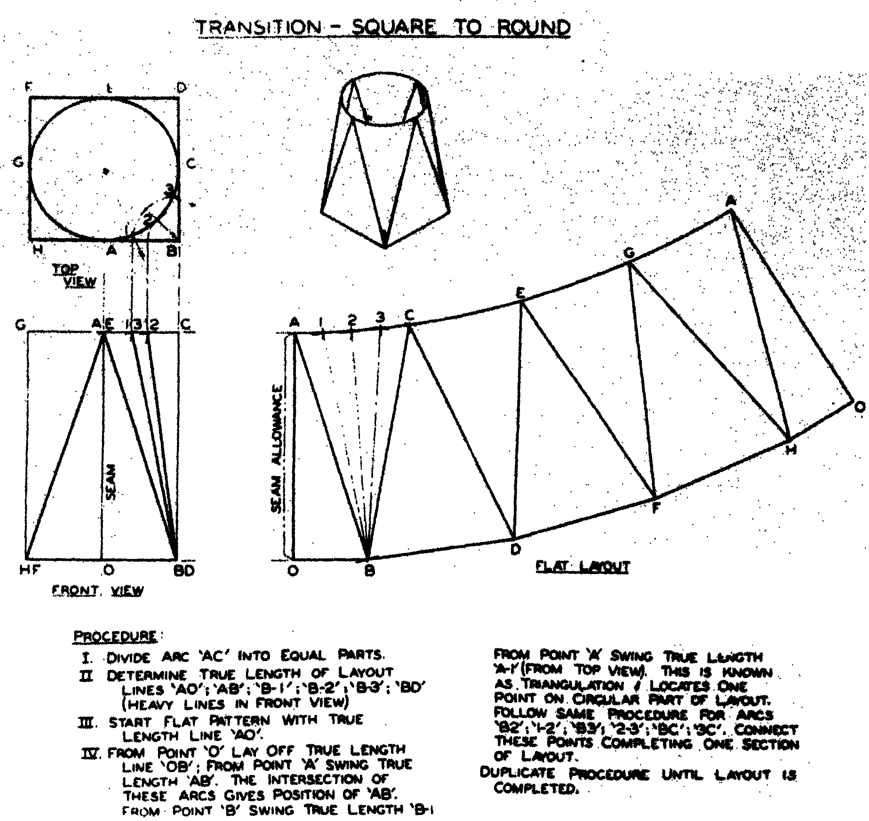
29-37. Making a pattern with a metal template.

FOUNDRY

The working drawings used by the patternmaker in the foundry show the finished dimensions of the object.

29-38. Developing a pattern for a pyramid.





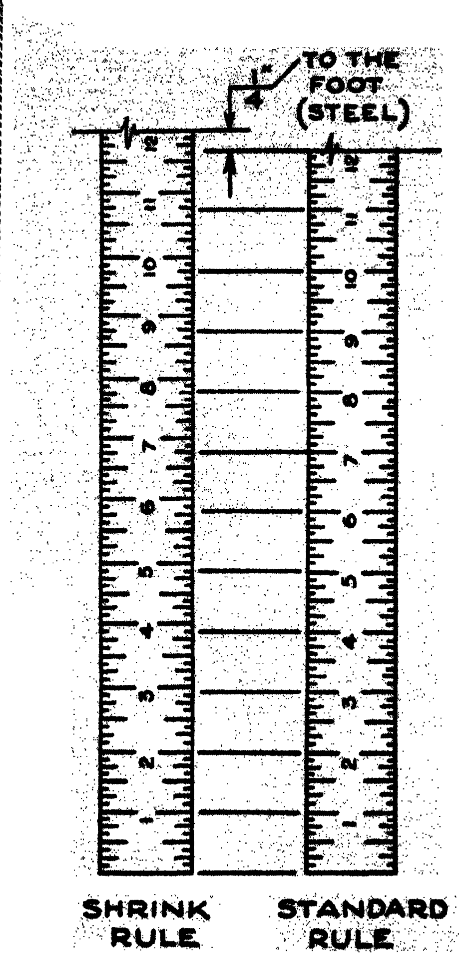
29-39. This is the method for making a transition piece from square to round.

Since metal shrinks when it cools, the pattern is made larger than the finished size. To do this the patternmaker uses a "shrink rule." A different shrink rule is needed for each different kind of metal. If the pattern is for an aluminum object, for example, the rule is actually 24½" long, instead of 2'. Each inch is slightly oversize. Fig. 29-42.

Patterns are usually made of wood. The sides are tapered slightly (about ⅛" to the foot so that the pattern will come out from the sand mold easily. This taper is called *draft*. The corners of a pattern are usually rounded off. The inside corners are called fillets and the outside corners are called rounds. Fillets or rounds are usually 3/16", ¼", or ⅜" in radius. Fig. 29-43. These fillets or rounds may be shown by a conventional line even though, according to drawing rules, no line would be drawn. The location of the line should be where edge or corner normally is. Fig. 29-44.

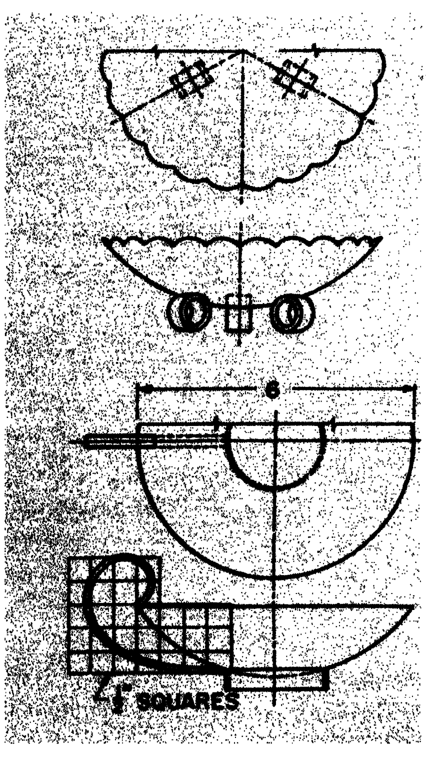
29-40. A one-view drawing is needed to do this metal foil work.

29-42. A shrink rule that could be used for making a pattern for a steel casting.

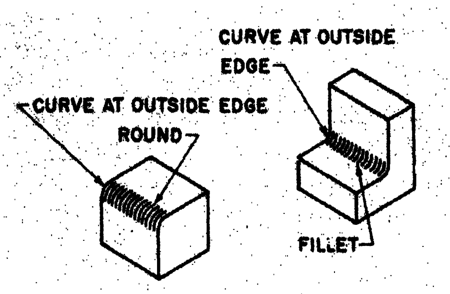


MACHINE SHOP

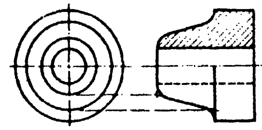
Machine drawings show the finished size of the object. If the object has been made as a casting or forg-



29-41. A two-view drawing is necessary for a tray or bowl.

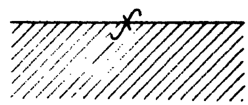


29-43. These are fillets and rounds.



29-44

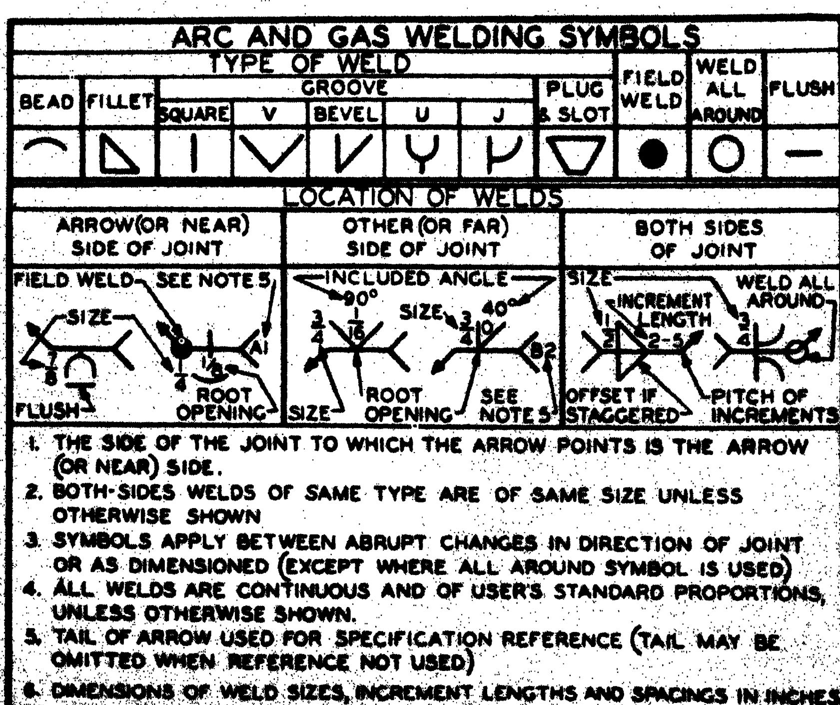
29-45



29-46

29-44. Notice that a line is used on one view to show where the edge or corner would normally be for the round or fillet. 29-45. The symbol used to show finished surfaces. 29-46. The old finish mark.

29-47. The symbols used in arc and gas welding.



ing, a finish mark is placed at all surfaces that are to be machined or finished. This is a 60-degree V mark, the point of which just touches the surface to be machined. Fig. 29-45. The older finish mark, shown in Fig. 29-46, is still used sometimes. Machine drawings frequently show two, three, or more different dimensions for the same hole or surface. The first dimension may show the size of the hole or surface as it is cast in the foundry. The second dimension may show the size of the hole or surface after it is machined. The third dimension may be the size of the hole or surface after it is finished by grinding.

In machine shop, *parts are never finished to perfect size.* This would take too long, cost too much, and is not necessary for interchangeability of parts. Therefore most machine drawings show the *limits* (or allowable error). For example, if a hole is to be 2″ in diameter, the drawing may show 2″ plus or minus .005″, (2 ± .005). This means that the hole can be anywhere from 1.995″ to 2.005″ in diameter. The difference between the upper and lower limit is called the *tolerance.* Sometimes the upper and lower limits are shown in decimals such as $\frac{2.346}{[illegible]}$. The limits

be shown on a drawing.

WELDING

Welding with arc or gas is used to join or assemble many metal objects. On most school-shop drawings an arrow with a note indicates the points to be welded. In commercial welding the symbols shown in Fig. 29-47 are used.

Section IV

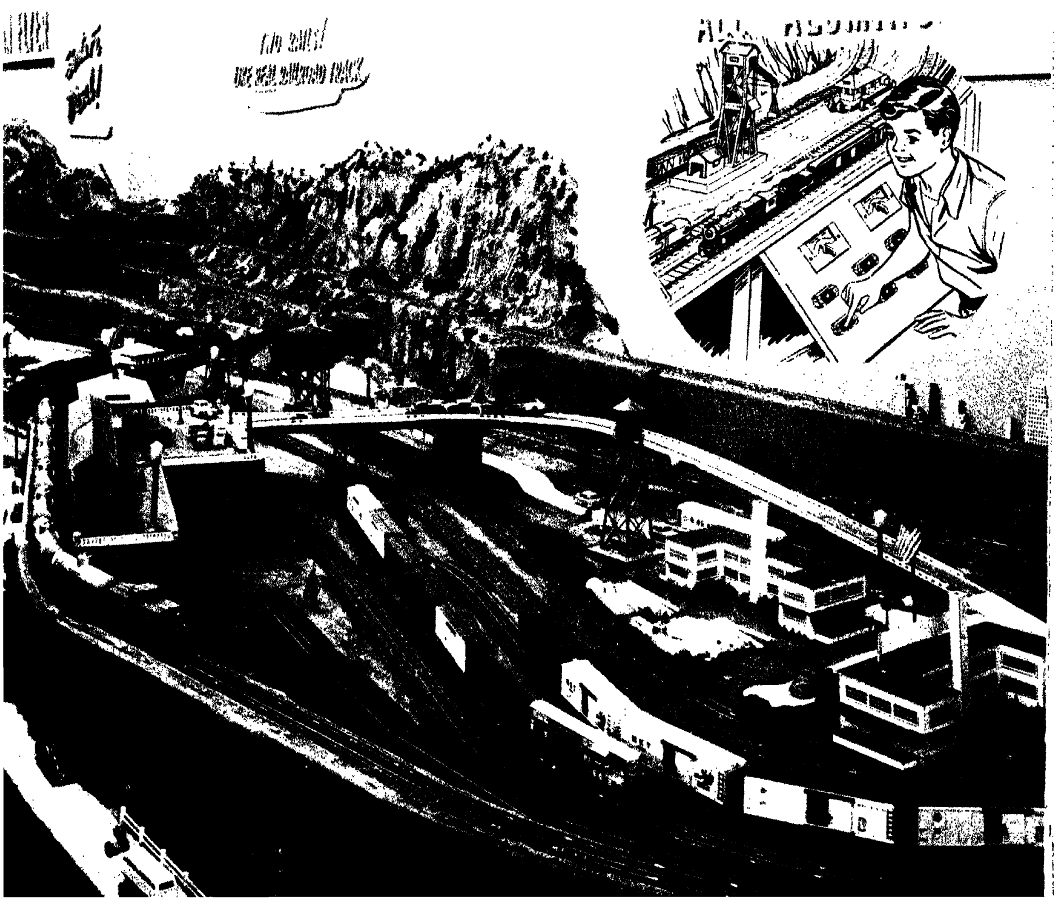
30. Electrical Drawing

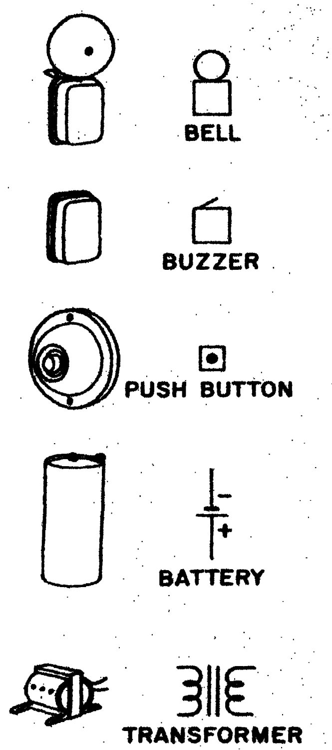
There are at least five different areas in electricity in which knowing how to make and read drawings is important. These are:

1. Low-voltage wiring.
2. House wiring.
3. Appliance servicing and repair.
4. Communication devices (radio, television, etc.).
5. Electrical projects.

Electricity is different from metal and wood because you can't see it. The drawings are of the *devices used*, such as a bell in low-voltage circuits,

30-1. Low voltage operates model trains by means of a transformer.





30-2. A picture and a symbol of each of the common low-voltage devices.

a switch in house wiring, or a tube in a radio. As you know, it would be very difficult to make a picture drawing of these. Therefore the electrician uses *symbols* (simplified pictures) to make his drawings.

Drawings made with these symbols are called *schematics*. A man who fixes radio and television sets will tell you he uses schematic drawings all of the time in his work. You should learn to make and read them in each area of electricity.

WHAT IS ELECTRICITY?

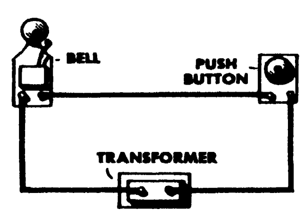
You use electricity every day. You toast your bread, read by light, listen to the radio, or watch television, all by electricity. Controlled electricity is said to be the flow of electrons along a wire then through electrical devices. To have the electrical flow, there must be a complete circuit. (Your movements from the time you leave home to the time you get back home at night are a *complete circuit.*) In all electrical drawings you must be able to trace circuits.

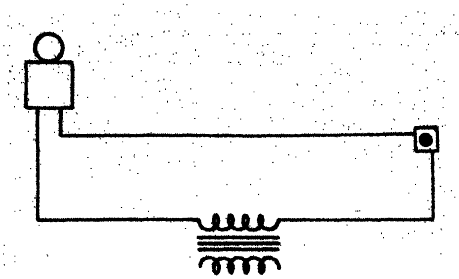
LOW VOLTAGE WIRING

Circuits. Low-voltage devices are those that operate on 18 volts or less. A model train, Fig. 30-1, the electric light on your bicycle, or a door chime are typical low-voltage circuits. Studying low-voltage circuits is a good way to learn the basic principles of electricity. The devices used are bells, buzzers, dry cells, push buttons, transformers, and wire. Here is a picture and a symbol for each: Fig. 30-2.

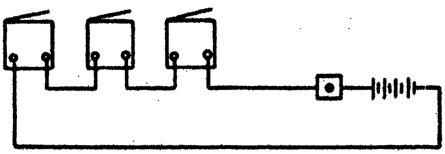
The simplest low-voltage circuit consists of a source of electricity, a transformer, the path (wire), a con-

30-3. A picture drawing of a simple circuit.

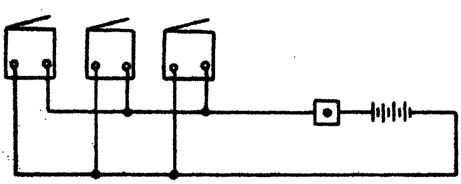




30-4. A schematic diagram or drawing of a simple circuit.



30-5. Three buzzers hooked in series.



30-6. Three buzzers hooked in parallel.

trol (push button), and the operating device (bell or buzzer). A picture drawing of this circuit would look like Fig. 30-3, while a schematic of the same circuit would appear as in Fig. 30-4. Can you trace this circuit on a schematic drawing? Place your finger on one side of the source. Follow the circuit along the wire, across the push button, along the wire, across the bell, and along the wire back to the transformer.

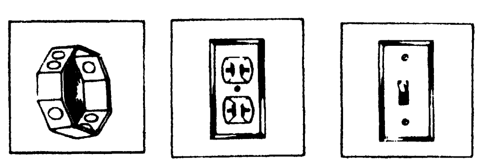
Schematic drawings can be made either freehand or with tools. They are usually made freehand. The symbols must be drawn clearly and correctly.

Series and Parallel Wiring. When there are several operating devices or controls, these can be hooked up in two different ways, *series* and *parallel*. In *series* wiring the devices are attached one right after another. Fig. 30-5. The electrons must flow continuously through one and then the other. A good example of series wiring is the old-fashioned string of Christmas tree lights. If one goes out, none will work. That is because there is a "break" in the circuit. In *parallel* wiring the devices are wired side by side, or in parallel. Fig. 30-6. Part of the electrons flow through each device all of the time. If one burns out the others continue burning. A house is wired in parallel.

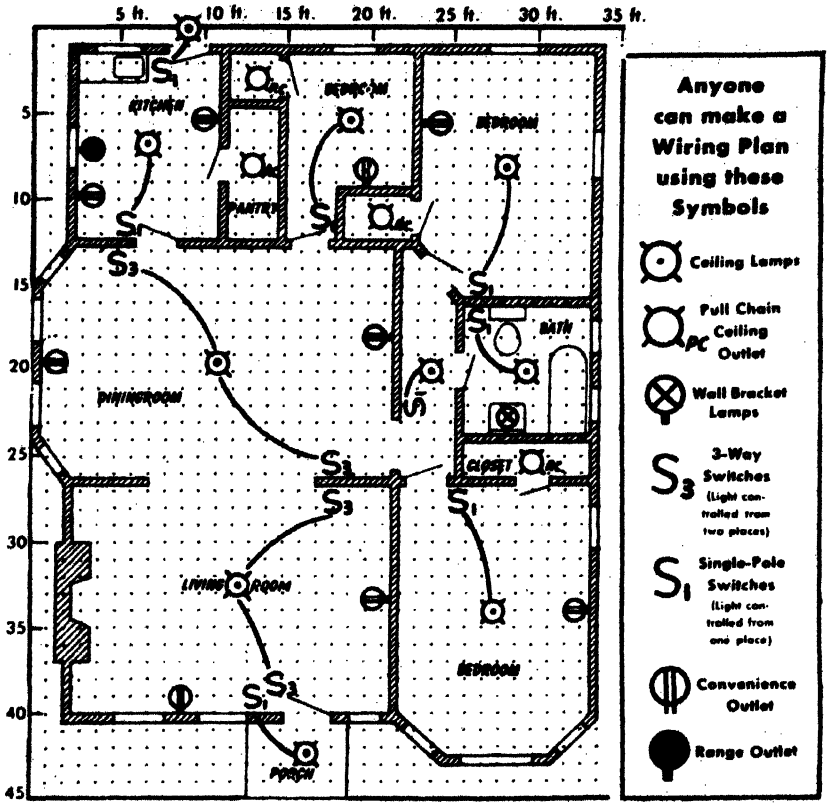
HOUSE WIRING

To plan the wiring for a house you must be acquainted with typical house-wiring devices. Fig. 30-7. In making a wiring diagram, proceed as follows:

30-7. Common house-wiring devices. A—box, B—convenience outlet, C—switch.



A B C



30-8. A one-view drawing showing the electrical symbols in use.

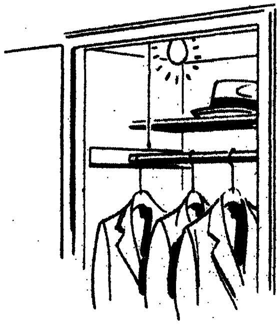
LIGHTING OUTLET: Means by which branch circuits are made available for connection to lampholders, to surface-mounted fixtures, to flush or recessed fixtures, or for extension to mounting devices for light sources in valances, cornices, or coves.

CONVENIENCE OUTLET: The plug-in receptacle, as well as the box in which it is housed. It shall be at least of the duplex type (two or more plug-in positions) except as otherwise specified. Multi-outlet assembly may be substituted, if desired, for the convenience outlets mentioned in these standards.

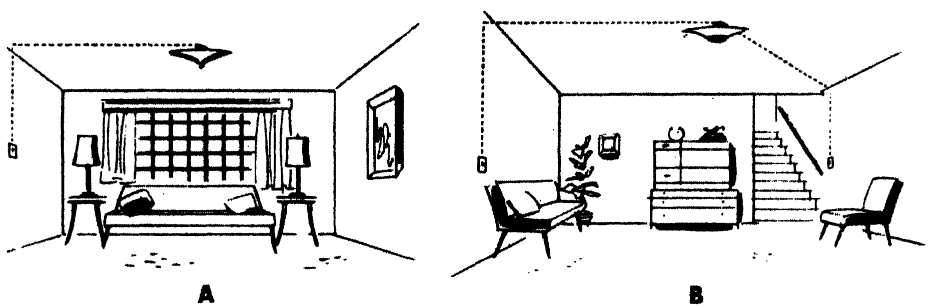
WALL SWITCH: A switch on the wall, not a part of any fixture, for the control of one or more outlets.

1. Make a one-view layout drawing of the house or other building. Fig. 30-8. Divide the layout into rooms. Name each one. Show the location of all doors and windows. Do this to scale, usually ¼″ to the foot. This will help in estimating the wiring materials needed.

2. Draw in the correct location for all ceiling outlets. Show whether they are drop fixtures, like a dining-room chandelier, or a pull-chain fixture



30-9. This is a typical use for a pull-chain fixture.



30-10. This illustrates the difference between (A) single-pole and (B) three-way switches.

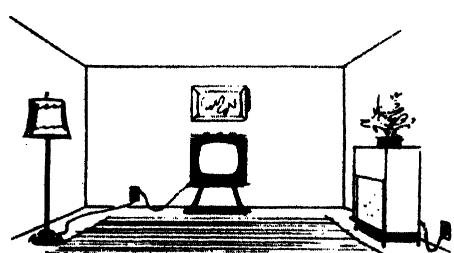
used in closets. Fig. 30-9.

3. Locate all of the switches near the doors. If the light is controlled from only one switch, it is called a single-pole switch. If a switch is located in two places to operate the same light, it is called a three-way switch. Fig. 30-10.

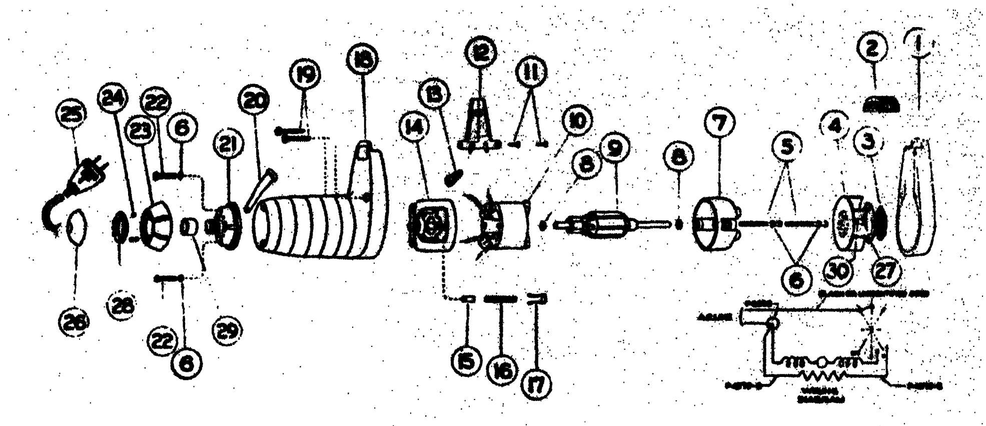
4. Locate the convenience outlets in each room. Fig. 30-11. Make sure there is at least one outlet on each wall and several on a long wall. Consider the appliances you will use, such as a radio, television set, lamps, and clocks. Also consider the appliances needed in the kitchen or workshop. It is cheaper to install a convenience outlet when building a house than after completion.

5. Locate the position for all wall lamps such as you would find near your medicine chest.

6. Determine the amount of wire and other electrical devices of each type you will need. Use the scale drawings to estimate the needs for



30-11. Common uses for convenience outlets.



30-12. An exploded pictorial drawing and a wiring diagram can be used to repair or maintain this hair dryer.

1. Outside cover (plastic)
2. Grille.
3. Intake Screen
4. Fan blade unit with S165 set screw
5. $^{6}/_{32}$ x $1^{7}/_{16}$ shoulder screw (2)
6. Washer
7. Fan end shell (inside)
8. Steel washer
9. Armature
10. Magnet
11. #4 by $^{3}/_{16}$" PK screw type F (2)
12. Heating element
13. Wire nut
14. Brush end shell (inside)
15. Carbon Brush
16. Brush spring

sh spring retainer

18. On

al head machine screw $^{6}/_{3}$ x $^{3}/_{4}$ (2)

20. Cc
22. Screw
25. Cord and plug
27. Retaining ring

Switch Parts

21. Switch housing assembly (1)
23. Rotor (plastic) (1)
24. Bronze ball (3)
26. Switch heel (plastic) (1)
28. Contact plate (1)
29. Insulator (2)

Stand for B97

wire. Remember that in the actual wiring of a house the wires must run in the walls. They must go up and down the side walls and in between the floors and ceilings.

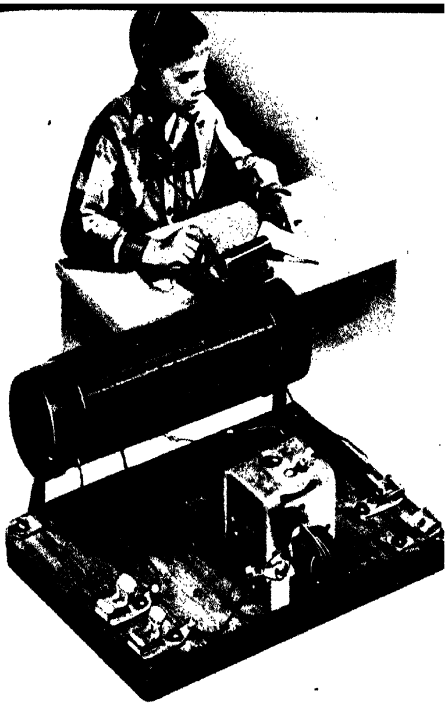
7. Plan the bill of materials for the layout.

APPLIANCE SERVICING AND REPAIR

There are two types of drawings used in appliance repair: an exploded assembly drawing, usually a pictorial drawing, and a schematic drawing. The manufacturer will supply both of these. They are used to order new parts, to install parts, and to check and correct defects. Fig. 30-12.

COMMUNICATION DEVICES

The common communication devices you use every day are the radio, television, and telephone. Fig. 30-13. You may also make use of the telegraph. Radio and television servicing



30-13. A crystal set is one of the simplest communication devices.

requires complete schematic drawings. There is one of these available for each different set manufactured. To the untrained person, these drawings look like "Greek." The symbols used to explain the set are very complex.

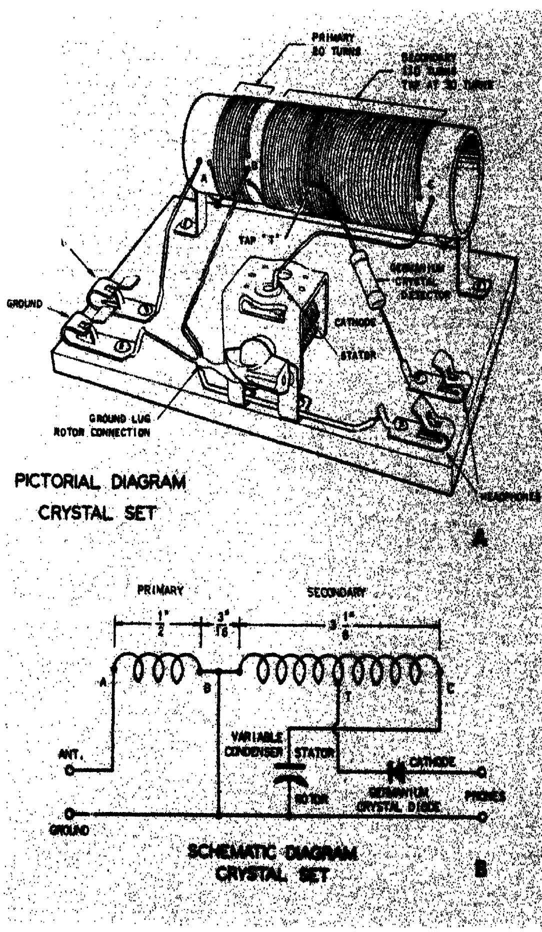
Here is a picture drawing and a schematic drawing of a simple crystal set you could build. Fig. 30-14. Fig. 30-15 shows the meaning of each of the symbols. In any futher study of radio and television, you will have to learn to read all kinds of schematic drawings.

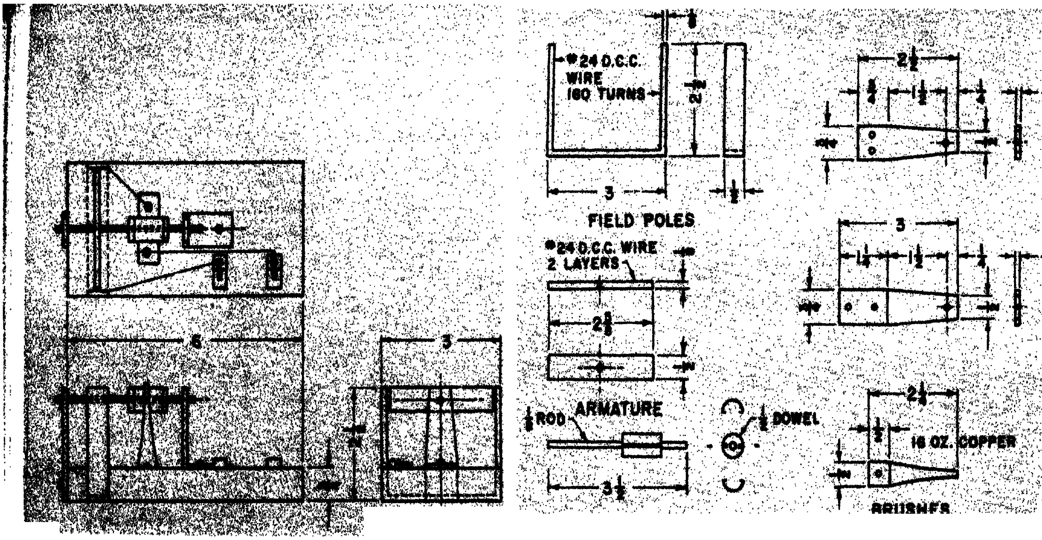
The telephone and telegraph make use of schematic drawings to explain how the systems work. Any good electrical book will explain these fully.

ELECTRICAL PROJECTS

There are three common types of electrical projects you will make in the shop. These are: (1) those that involve light, such as a lamp for your room; (2) those that involve motion, like a telegraph sounder or motor; and (3) those that involve heat and cold, such as a burning pencil, solder-

30-14. A picture drawing and a schematic diagram of the crystal set.

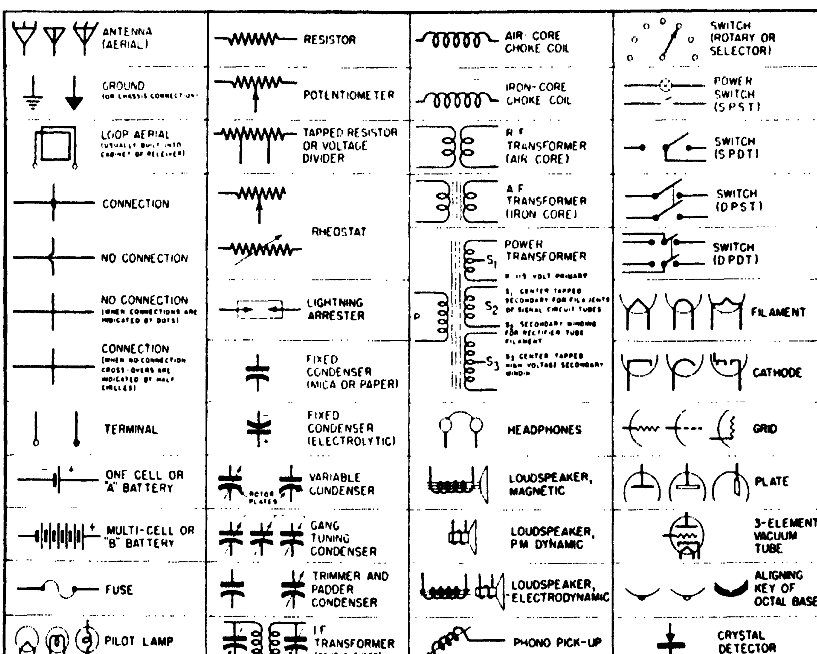




30-16. A drawing of a small electric motor.

ing copper, or hot-dog roaster. You will discover that project drawings in electricity do not follow standard drawing practice. They are usually combinations of a picture or working assembly drawing and a detail drawing of each of the major parts. A typical drawing of this type is the small electrical motor shown in Fig. 30-16.

30-15. Symbols used in radio work.



Section IV

31. Graphic Arts Drawing

Everyone enjoys looking at a good magazine or reading the newspaper. Every day you make use of things that are printed or duplicated. This book you are reading is a good example of printing. Everything that is duplicated, whether it's done on a typewriter, mimeograph machine, or printing press, is an example of graphic arts. Printing is one of the largest industries in the United States. You may have a printing or graphic-arts shop or a unit in printing in a general shop in your own school. Even if you do not, you should become acquainted with how drawing and designing are used in such arts as printing, linoleum-block work, and silk screen.

PRINTING

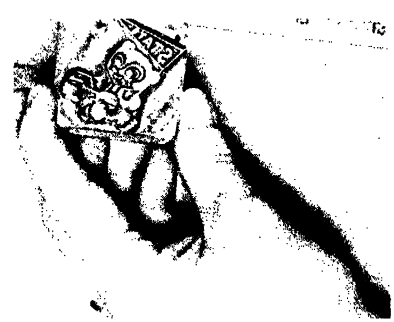
Before you can print a ticket, a poster, or a card, a *layout* of the job must be made. This is a one-view drawing showing the size, shape, and general appearance of the complete job. Before you can make this layout you need to know something about printing.

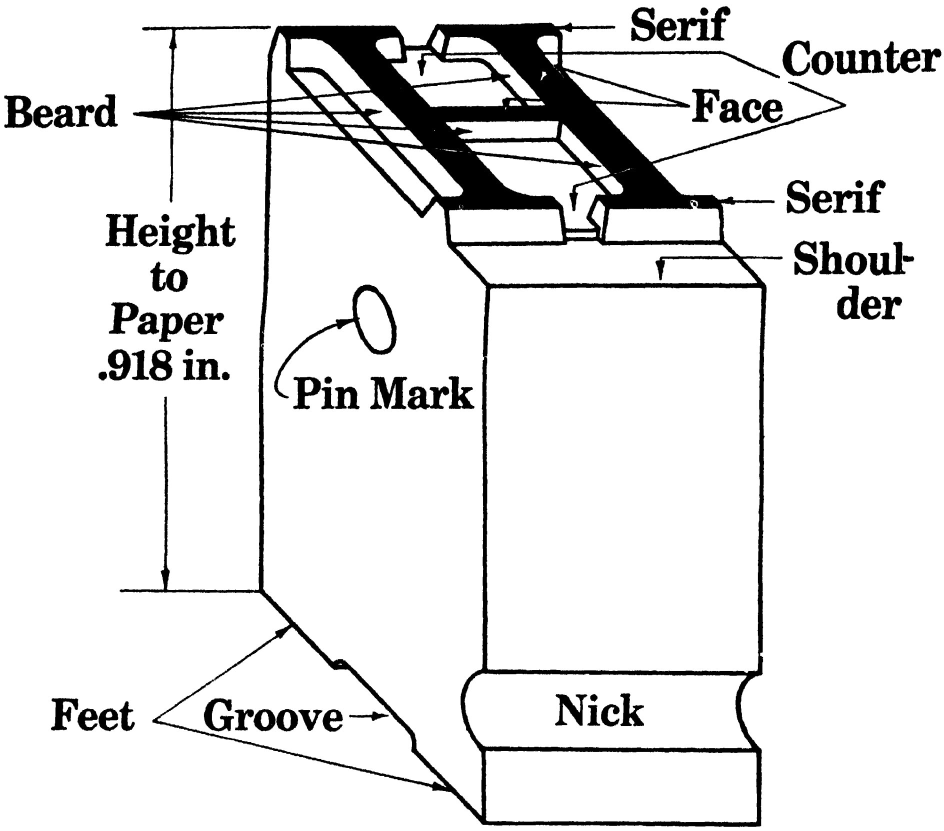
Printers' Measurement. The printer uses a system of measurement as follows: 12 points equal one pica, 6 picas equal one inch, and 72 points equal one inch. Printers use a special rule called a line gauge or type rule. Fig. 31-1. This is divided into points, picas, and inches.

Type. Printing is done by setting the copy in type. In addition, illustrations are often added. Photographs or shaded drawings are made into halftone engravings. Line drawings are made into line etchings. This book has good examples of both of these.

Type is a small piece of metal with a raised letter or character on it. Fig. 31-2. Type is measured in points. For example, this page is set in

31-1. A line gauge or type rule used to measure in printing.





31-2. The parts of a type.

11 point type. The type is designed in many styles of typeface. Type in any one face is available in many sizes. Fig. 31-3. Some of the common ones used in the school shop are shown in Fig. 31-4. Each size of hand-set type is kept in a California job case. Fig. 31-5. Borders, ornaments, halftone engravings, and line etchings are also used in printing.

MAKING A LAYOUT

In making a layout, always use the line gauge as a rule. The length of the line of copy is always stated in picas and the space between the lines is given in points. The following information must be included.

1. The width and length of the printed matter in picas.
2. The size of the type in points.
3. The style or name of the type.
4. Other information such as borders, halftones, line etchings, ornaments, and colors of printing. The layout must also show whether the type is upper or lower case (capitals or small letters).

Proceed as follows to make the layout:

1. Make several rough sketches of the job. Suppose, for example, the job is to be a ticket for a basketball game. You must decide what information is to be included and how this information is to be arranged. Sketch several possible layouts. Remember that balance and proportion are important to an attractive layout.

2. Select the sketch that is most pleasing to the eye.

3. Make a detailed layout of the job, giving all the necessary information about the job. Fig. 31-6 shows a layout and a finished ticket.

This is 6 Point

This is 8 Point

This is 10 Point

This is 12 Point

This is 14 Point

This is 18 Point

This is 24 Point

This is 30

This is 36

31-3. Common sizes of one type face.

LINOLEUM-BLOCK PRINTING

For Christmas cards, posters, tags, and other similar things, a design can be printed with a linoleum block. Fig. 31-7. You can develop any kind of design you choose which is then carved in the linoleum with sharp tools. Because of the method of making this block, the design should be quite simple. You may enlarge or reduce the design that you have seen in a book or magazine, but it is better to make your own.

After you have decided on your design, it must be drawn in reverse on a block. This is done by placing a piece of carbon paper face up on a table. Place your design over the carbon paper and trace it. The back of the paper will have the design in reverse. Then place the carbon paper over the block and trace the design in reverse on the linoleum.

SILK-SCREEN PRINTING

Silk screen is a process of duplicating on paper, cloth, and other materials. The process is very simple. A wooden frame is made over which is stretched a thin silk or organdy cloth. This cloth is porous. The special paint can go through it. Now, draw a design. Place a special film over the design. With a stencil knife cut around the design through the orange coating of the film. This orange film coating is then stripped off with a stencil knife. The design

Oldstyle

Cloister Oldstyle *and Italic*

Garamond *and Italic*

Caslon 540 *and Italic*

Goudy Oldstyle *and Italic*

Century Oldstyle *and Italic*

—Sans Serif

Bernhard Gothic *and Italic*

Spartan *and Italic*

Lydian *and Italic*

Franklin Gothic *and Italic*

—Square Serif

Stymie *and Italic*

Modern

Bodoni *and Italic*

Bulmer Roman *and Italic*

Modern Roman *and Italic*

—Text

Wedding Text Engravers Old English

Cloister Black American Text

—Script —Cursive

Kaufmann Script Grayda

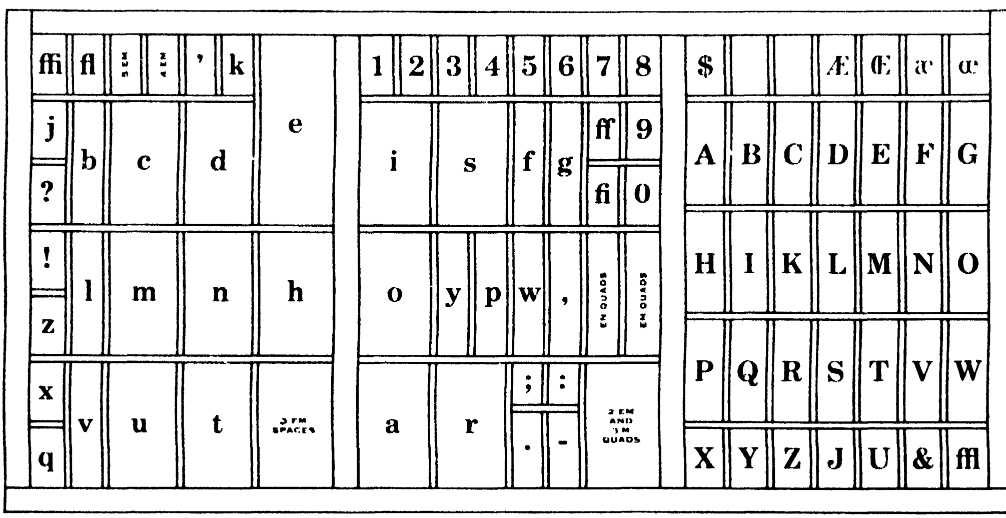
Bank Script Lydian Cursive

—Novelty

BALLOON HUXLEY VERTICAL SHADOW

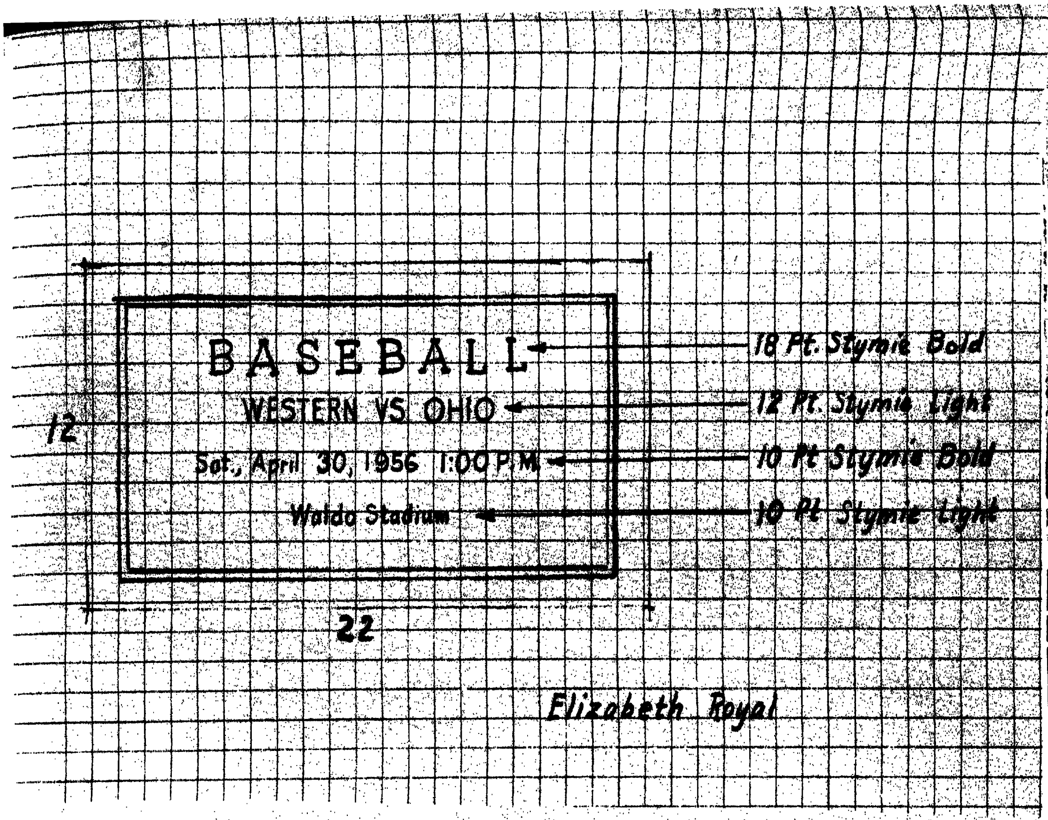
STENCIL Romany Onyx

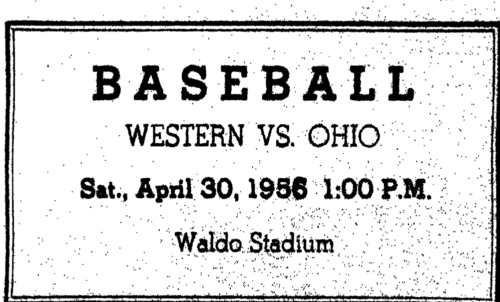
31-4. Popular type faces.



31-5. The layout of a California job case.

will print when the coating is removed. Fasten this stencil to the underside of the frame, attaching it to the screen. Now the whole frame is placed over the material to be printed. Special ink or paint is poured inside the frame at one end. Then, with a squeegee, such as you use to





31-6. The layout and the finished job in printing.

wash windows, spread the paint around, forcing the paint through the cloth.

The designs for silk screen printing should be simple shapes.

31-7. A linoleum block print.

Section IV

32. Arts and Crafts Drawing

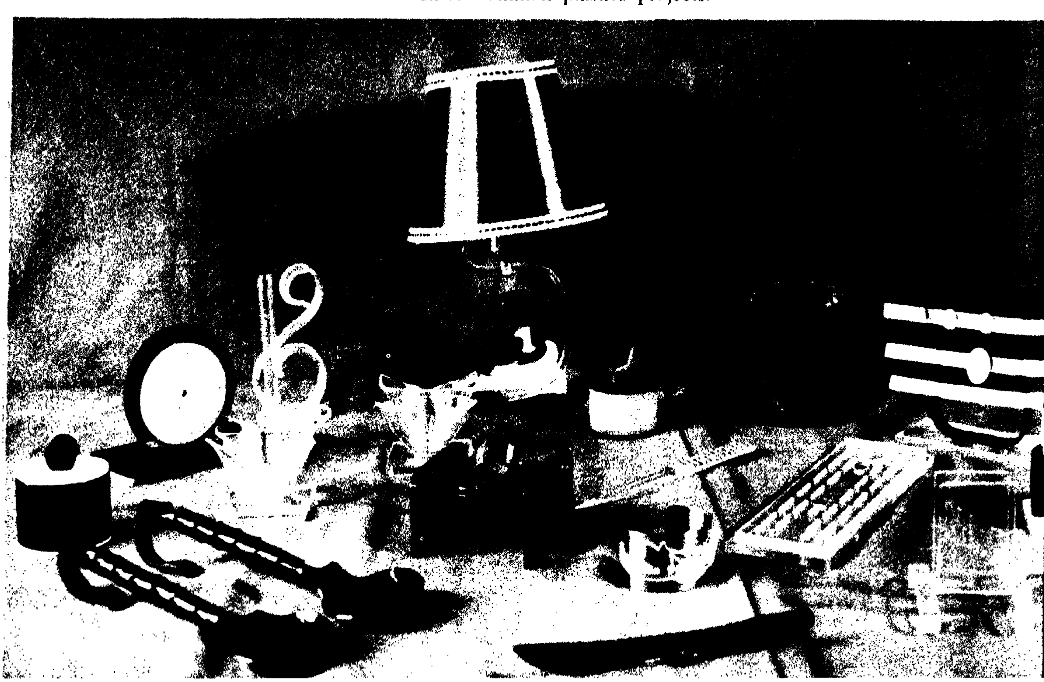
People like to do many different things as hobbies. You may enjoy collecting things, while the person next door prefers to build things in his spare time. Many people do woodworking and furniture making as a hobby. Making jewelry and doing other kinds of metalworking are also very popular. There are five other very popular creative hobbies: namely, plastics, leatherwork, archery, wood carving and model making. Drawings and plans are needed, as with anything you make or build.

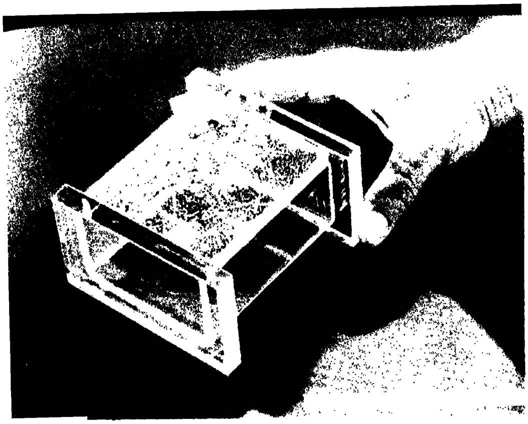
PLASTICS

The two common types of plastics for craftwork are the *acrylic* and *phenolic* resins. Fig. 32-1.

The acrylics are called thermo plastic because they can be heated and bent to change their shape. Common trade-names are Lucite and Plexiglas. These are especially good because they cement easily, take a good polish, and can be bent with ease when heated. They can be purchased in sheets, bars, rods, and tubes, much like metal supplies.

32-1. Common plastics projects.





32-2. A plastic cigarette box with a laminated top.

Phenolic resin plastics are called thermo setting. This means that once this plastic has been poured into shape by the manufacturer, it cannot be changed by reheating. For hobby-work you can buy this kind in rods and tubes in many shapes and colors. The rod shape, for example, might have been cast in the form of a dog, flower, or bird. This can be cut the desired thicknesses to make pins, bracelets, and other items.

Plastics are worked with metal and wood tools. The drawings needed are very similar also. For simple projects a one-view drawing is all that is necessary. The design on squared paper is fastened directly to the plastics to make such projects as a letter opener, a pin, or a buckle. For other projects a two- or three-view working or pictorial drawing is needed. Figs. 32-2 and 32-3. Plastics offer you a good chance to design your own projects. Keep these points in mind:

1. Acrylic plastics can easily be bent to shape. Use them to design unusual shapes not possible in metal or wood.

2. Acrylic plastics are so crystal clear that they require very little surface decoration. They will conduct light around corners and curves. This feature can be used to good advantage in designing lamps.

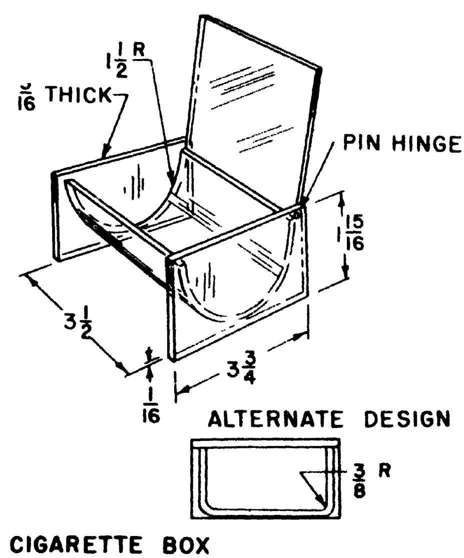
3. Plastics can be combined with metal or wood.

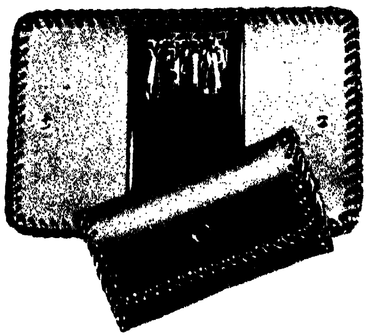
4. Plastics are available in such a wide variety of colors or can be dyed so many colors that the color combination is an important part of the design.

5. Standard shapes of phenolic resin plastics will determine to a great extent the design of your project.

6. Plastics can be decorated by internal carving and dyeing.

32-3. A drawing for the cigarette box.





32-4. Typical leather projects.

Sheets of acrylic plastic come covered with masking tape to protect the surface. Make the layout directly on this paper. Cut out the material before the tape is removed.

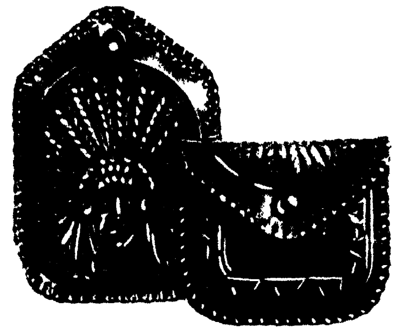
LEATHER

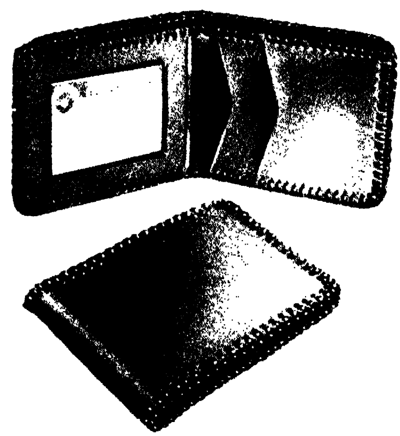
Leather objects such as coin purses, key cases, and billfolds are made from skins and hides. Fig. 32-4. Some leathers have the wonderful quality of softness. This makes it possible to tool a design in the surface.

All leatherwork drawings are one-view, as follows:

1. Pattern or layout drawing for the parts of the project. Fig. 32-5.
2. The surface design, if there is one, that is to be tooled on the outside pieces.

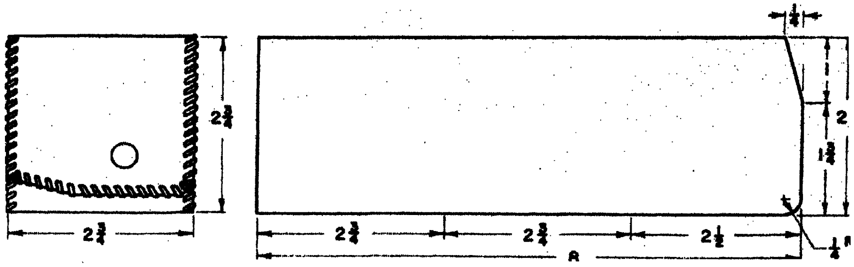
Leather projects offer you a good opportunity to make your own designs, especially in decoration. Pattern drawings are placed on squared paper since they are irregular in shape. They are usually not drawn full size in books, magazines, and project pamphlets. Enlarge drawing before transferring to leather.



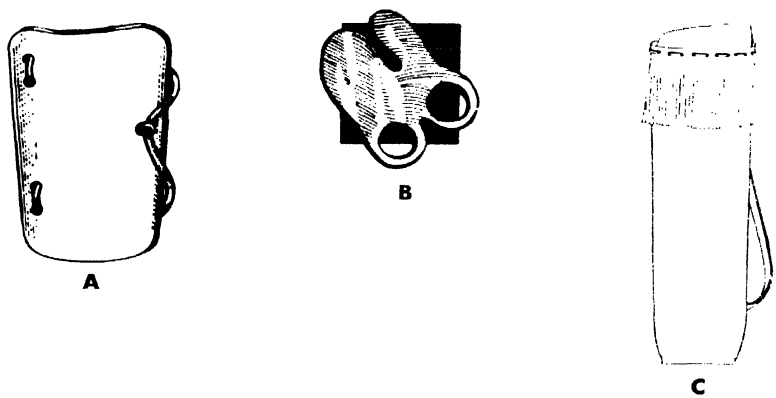


ARCHERY

For archery you need bow, arrows, and leather equipment such as arm guard, tab, finger guard, and quiver. Fig. 32-6. You can buy the archery bow in rough wood (stave). The drawing for a bow is a good example of section drawing. The bow is not the same shape at any two places along its length! Fig. 32-7. Therefore a cross-section must be drawn at

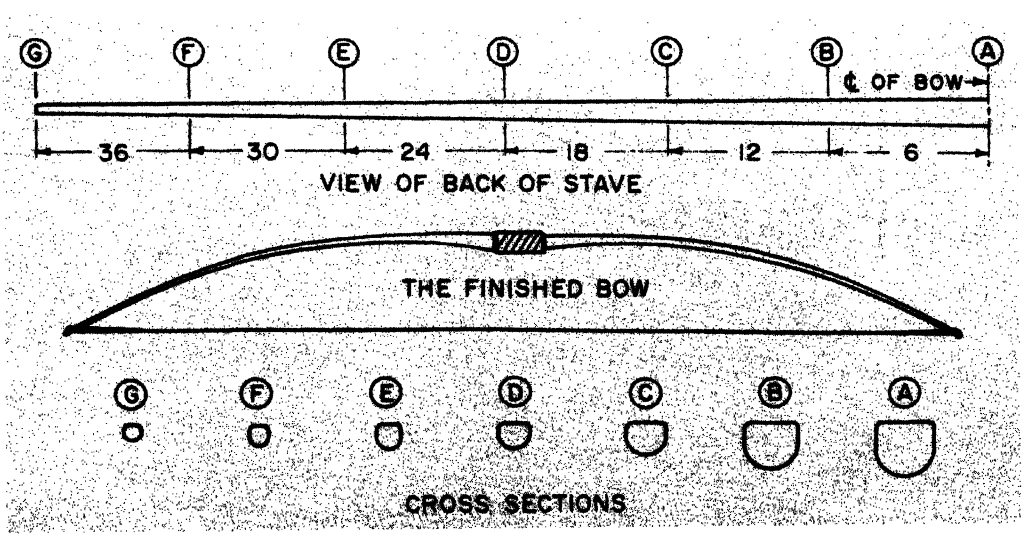


32-5. A pattern or layout drawing for a coin purse.

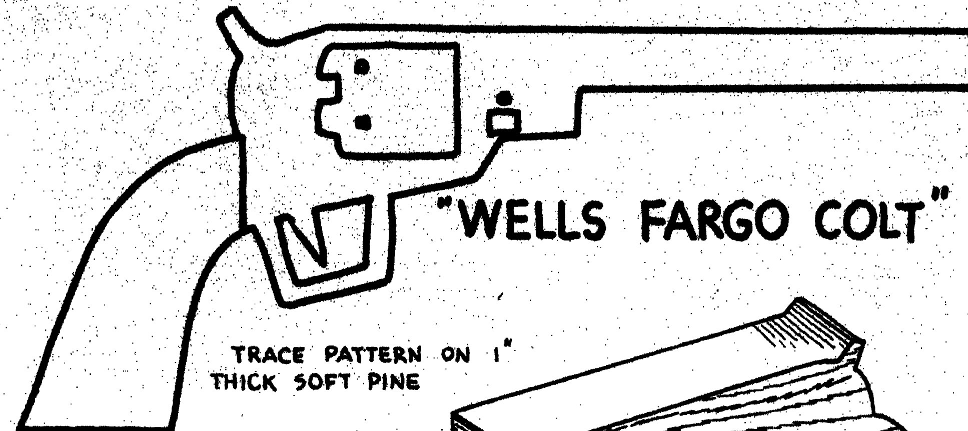


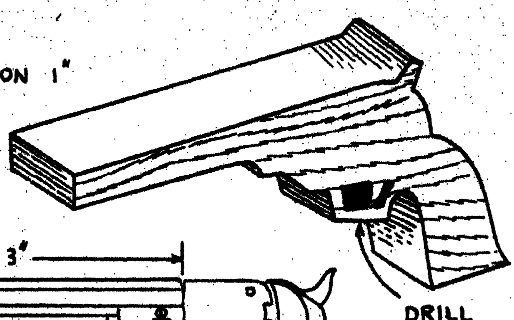
32-6. The accessories used in archery: a. Arm guard. b. Finger tab. c. Quiver.

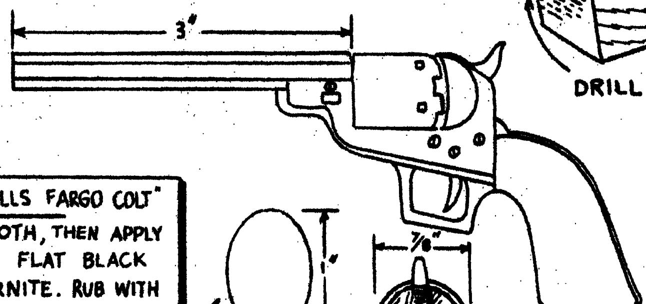
32-7. A drawing for a bow. Notice the sectional views showing the cross sectional shape of the bow at the different points.



"WELLS FARGO COLT"

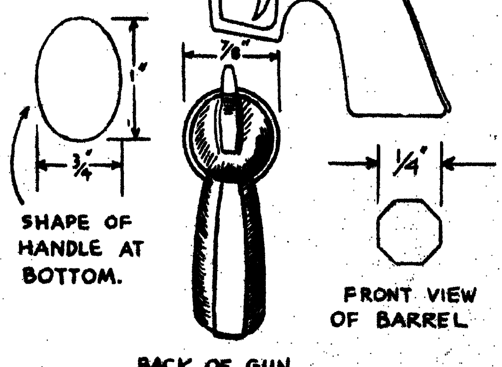


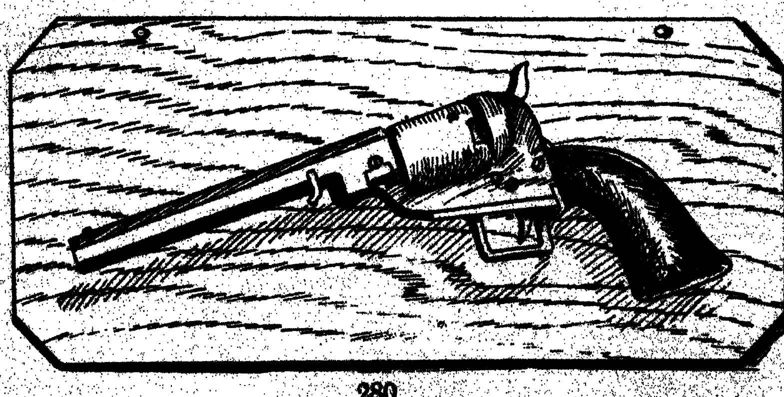




HOW TO FINISH "WELLS FARGO COLT"

SANDPAPER SMOOTH, THEN APPLY A THIN COAT OF FLAT BLACK PAINT. DRY OVERNITE. RUB WITH POWDERED PUMICE UNTIL PAINT IS WORN DOWN. WIPE OFF PUMICE, AND RUB GRAPHITE INTO THE WOOD WITH A SOFT CLOTH. REPEAT GRAPHITE BLOW OFF SURPLUS. APPLY A THIN COAT OF CLEAR VARNISH, SHOULD BE PLACED ON WITHOUT TO MUCH BRUSHING.





32-8

several locations to show the shape of the bow. The leather equipment requires pattern drawing also.

WOOD CARVING

Figures carved from wood offer you another chance to design. Hobby books usually have view drawings of wood carvings. Fig. 32-8. These are often combined with a picture drawing of the finished article. In making a wood carving, the pattern is traced on two or three surfaces of the wood. It is then cut out with a jig saw or coping saw before the finished carving is done.

MODEL MAKING

Most of the drawings used for model making are pictorial assembly drawings and pattern drawings of the parts. These are used in all kinds of model making such as airplane, car and train models. The pattern drawings are used to lay out and cut the parts to size. The assembly drawing shows how the parts of the model go together.

Section IV

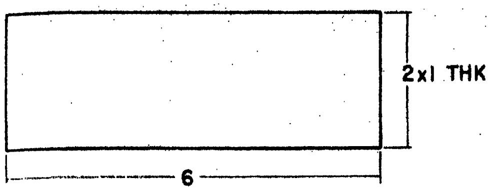
33. Simplified Shop Drawing

Often in this book you have been reminded that a drawing is made for one main purpose: *so the object can be built.* The drawing doesn't have to be pretty or artistic. The simpler the drawing the better, just as long as it is accurate. The drawing must contain all the necessary information for the workmen using it for construction.

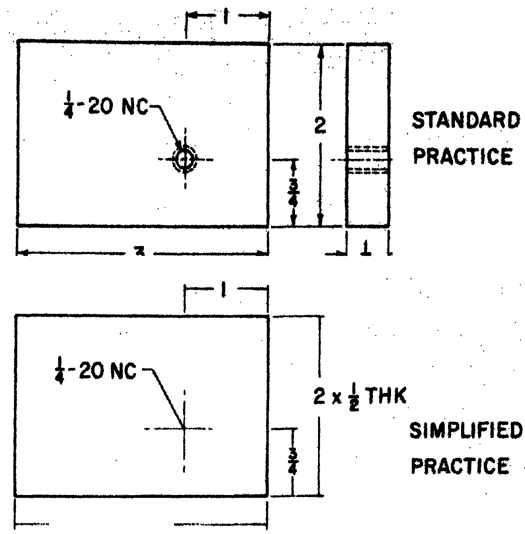
The units you have studied so far have followed the standard procedures in drawing. These have been used for many years and are generally accepted as standard. Many of the units have covered a single procedure very completely. This was done so that you would understand the fundamentals of drawing.

Progress is made when something can be done quicker, cheaper and with less effort than before. Companies try to do this with each new model of a product they build. The car of today has far fewer points for greasing than the car of only a few years ago. Today we can produce twice as much electricity from a pound of coal as we were able to do only a few years ago. Progress is also being made in the way drawings are done. Many companies and some professions interested in drawing are beginning to use more simplified methods. Drawings may seem strange with these newer, simpler methods but they are just as useful. *Many of the suggestions that follow have not been accepted by everyone who draws.* You should therefore know both the standard practices and the more simplified methods.

1. Using only the necessary views (or perhaps no view at all). You know that most working (view) drawings show two or three views of the object. The oilstone in Fig. 12-20 was drawn with three views. Actually it would not have been necessary to draw all three views. For example, a one-view drawing showing the width and length would have been enough, although a note telling the thickness must be added. Fig. 33-1. For an object as simple as this oilstone, no drawing at all would be needed. The oilstone could be made by knowing the dimensions 1″ x 2″ x 6″. Your time is important in drawing and unless a view serves a necessary purpose, don't waste your time by drawing it. A good example of a most useless drawing would be three views of a ball. Every view



33-1. A simplified drawing of the oilstone shown in Fig. 12-20. Note how much time would be saved by drawing the object as shown here.



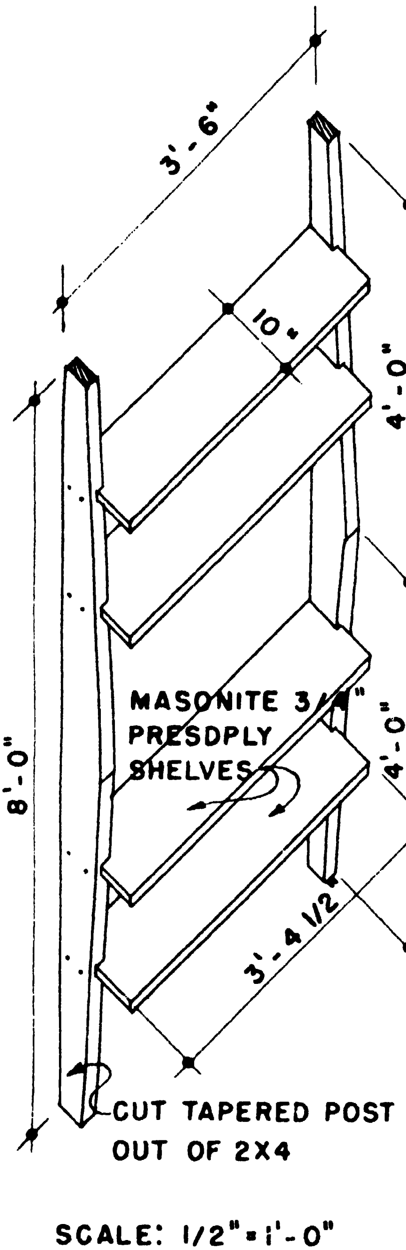
33-2. The regular and simplified method of drawing a simple metal part.

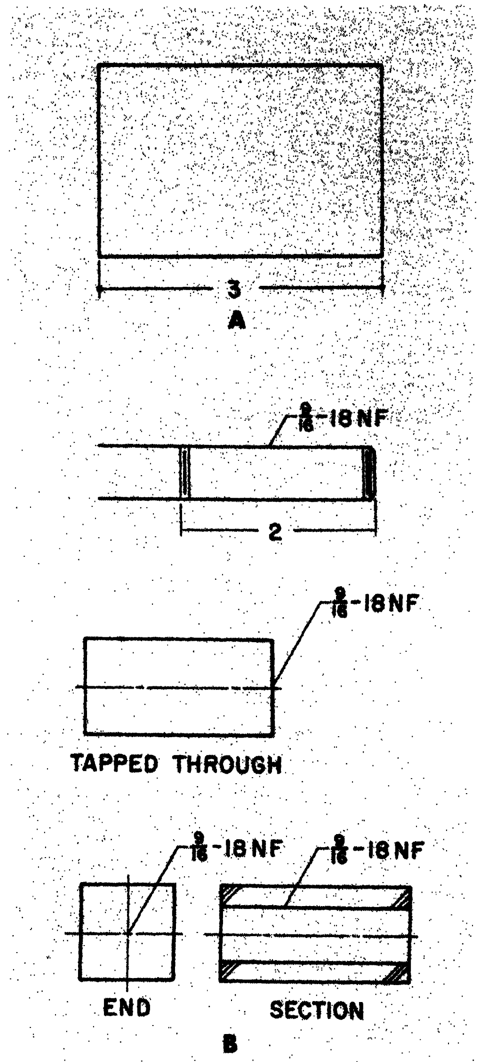
would be the same. Many drawings of rectangular-shaped objects can be completely useful with only one view. Fig. 33-2. Add notes whenever possible to eliminate the need for an extra view.

2. Using no arrowheads. Arrowheads take a lot of time to draw, especially if the drawing is complicated. Some manufacturers and architects have stopped using arrowheads. Also in some architectural drawings you see the dimension line drawn slightly beyond the extension line. A dot is placed at the point of intersection. The dot takes the place of an arrowhead. Fig. 33-3. Other draftsmen draw the dimension line up to the extension line and place a 1/16" dot or circle at the place where the lines join. Fig. 33-4A. You find this method used on many furniture drawings. Some companies have eliminated both the arrowheads and the dots. Only the extension and dimension lines are drawn, as shown in Fig. 33-4B.

3. Using very simplified thread symbols. A most difficult and useless drawing is one that shows threads as they actually are. You will remember that the important information about threads is given in the note. Therefore symbols are used to show only that it is a thread. The workman reads the note to find out what size and kind of thread to make. Regular thread symbols take a good deal of time to draw also. Simplified thread symbols are quicker. An even simpler and quicker method to represent threads is shown in Fig. 33-4B. Notice that there isn't even a hole drawn to show an internal thread. The center line tells the location of the thread and a note gives the size and kind of the thread.

4. Using very simple section drawing. A good deal of time is necessary to draw a section view with cross-hatching or section lines. Often a section drawing is made when one isn't really necessary. If a section view is to be made, time can be saved by showing only a few section lines instead of covering all. Fig. 33-4B.





33-4. A. Another method of using dots or small circles instead of arrowheads. B. No dots or arrowheads at all. Also a very simple method of showing internal and external threads. Only two or three cross-hatching or section lines are used.

33-3. A drawing of a built-in shelf showing the use of dots instead of arrowheads. Notice how the dimension line is drawn slightly beyond the extension line.

5. Using templates to simplify the drawing. Whenever possible, plastic templates can be used

to draw all standard shapes. Templates are available for the geometric shapes such as squares, circles, ovals, hexagons, etc. They are also available for making electrical, architectural, radio and many other symbols.

6. Using a typewriter instead of hand lettering. Notes and dimensions can be placed on a drawing with a typewriter. This method takes far less time than hand lettering. Information that is typewritten is just as clear and easy to read as hand lettering. It also duplicates very well.

7. Making tracings with a pencil. It is very time consuming to make an ink tracing. For most work this is not necessary. A pencil tracing will reproduce very well. Only for very special work is inking done in some companies.

8. Doing freehand sketching or shop sketching. If you are skillful, much time can be saved by making a freehand sketch or a shop sketch instead of a mechanical drawing. If you are going to use the drawing yourself, a sketch will do. A good shop sketch will serve for many purposes if it is well done. You will have great use for freehand sketching or shop sketching in everyday life. Remember, though, that a drawing must be accurate to be useful.

PROBLEMS—SECTION IV

Section IV—QUESTIONS AND TOPICS FOR DISCUSSION

1. Name some of the materials used in woodworking and describe how they are purchased.
2. Name the four common ways of joining wood.
3. Which methods are actually shown on a drawing? How are they shown?
4. In what ways are woodworking drawings different from other kinds?
5. Describe these three kinds of drawings as they apply to woodworking: working view, cabinet and isometric.
6. How would you go about making a working drawing from a sketch?
7. Name as many areas in metalworking as you can.
8. What are the kinds and shapes of metal used in the shop?
9. What is a thread? On what kind of metal fasteners are threads found?
10. Explain how screw threads are drawn. How is a tapped hole drawn?
11. What are some drawing practices that apply directly to these areas of metalworking: bench metal, wrought iron, sheet metal, art metal, foundry, machine shop, and welding?
12. What is electricity?
13. Since electricity itself cannot be drawn, what actually is included in drawings of electricity?
14. How would you show an example of each of the following: low-voltage wiring, house wiring, appliance servicing and repair, and communication devices?
15. Name the three types of electrical projects you can make in the shop.
16. Can you explain about type and how printing is done?
17. How would you make a layout for a printed article such as a ticket or poster?
18. How is linoleum-block printing done? Silk-screen printing?
19. How is the design put on the linoleum?
20. Explain why designs for silk-screen printing should be simple.

21. Drawings needed for plastics art work are similar to what other field?

22. Name the two kinds of plastics and decribe in what shapes they can be purchased.

23. Drawings for leather craft require how many views? Explain your answer.

24. A bow for archery must be drawn in section. Why?

25. How many and what kind of drawings are needed for making a wood carving? For model carving?

Section IV—SELF-CHECKING WHAT YOU HAVE LEARNED

PART I. True-False

1. A shop sketch is all that is needed to build a simple wood project.

2. Plywood is sold by the square foot.

3. The exact kind of woodworking joint is always shown on the drawing.

4. The size of wood screws needed for the project is always given on the drawing.

5. Woodworking drawings follow the same strict rules as those used in metal-working.

6. A working drawing of a piece of furniture can be developed from a picture or sketch.

7. A board foot of lumber is 1" thick, 12" wide and 12" long.

8. A dado is a groove cut with the grain of the wood.

9. A chamfer is an angle cut across the entire edge or end of a piece of stock.

10. A spline is a small piece of round wood used to strengthen a joint.

11. The three common shapes of heads of wood screws are round, button and oval.

12. A drawing for a woodworking project may include both an isometric and a view drawing.

13. A cabinet drawing is a good type for rectangular shaped furniture pieces.

14. An isometric drawing would be a good type to use for a turned lamp.

15. A thread is V-shaped groove cut around the outside of a rod or the inside of a hole.

16. The American Standard thread form has a flat crest and a rounded root.

17. A thread symbol tells the size and number of threads per inch.

18. The heads of machine bolts are made with either square or octagon heads.

19. Machine screw number 8-32 means that the thread diameter is $\frac{8}{32}$".

20. One-pound sheet-metal rivet means that 1000 of these rivets weigh one pound.

21. Patterns for funnels are made by the parallel line method.

22. Simple electrical drawings are usually made freehand.

23. A simple low-voltage circuit consists of a bell or buzzer, wire and push button.

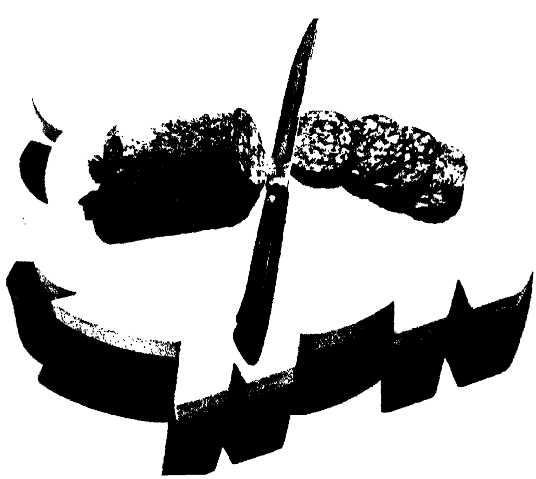
24. In the printer's system of measurement, 16 points equal one inch.

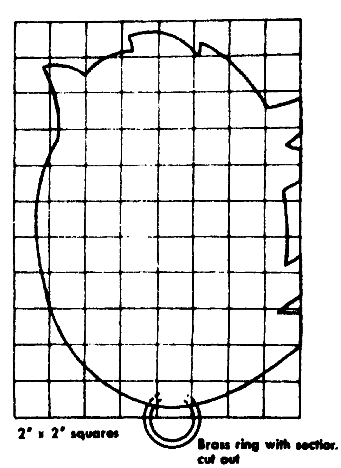
25. Designs for linoleum blocks can be quite complicated.

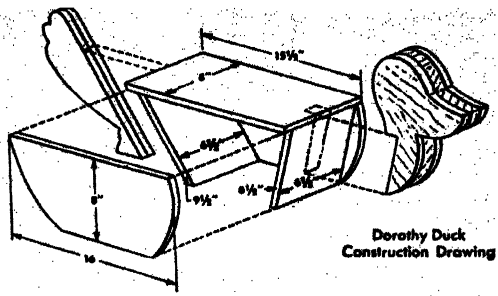
26. Wood tools will be ruined if they are used to work plastics.

27. Drawings for leather projects are usually made on squared paper.

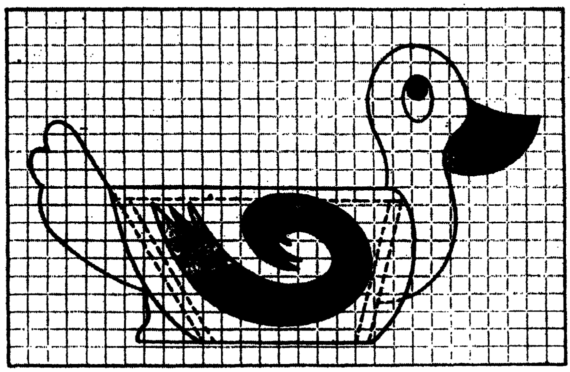
IV-A-1







Dorothy Duck
Construction Drawing



Dorothy Duck—Graph
(Each square = 1" square)

IV-A-2

PART II. Fill In

1. There are three board feet of lumber in a piece 1" thick, 12" wide and ______ inches long.

2. There are ______ basic types of woodworking joints.

3. The size of screws is shown by the ______ and the ______.

4. Internal threads are cut at the bench with a ______.

5. External threads are cut at the bench with a ______.

6. The thread form agreed upon by the United States, Britain and Canada is called the ______.

7. Metals such as copper and aluminum are classified as ______ metals.

8. Threads are shown on a drawing by two different symbols, ______ and simplified.

9. The thread series identified by the letters NC is the ______ series.

10. The ordinary threaded fastener is made with a No. ______ fit.

11. The important information about a thread is given in a ______.

12. The ______ screws are much like machine screws.

13. A fastener used to hold two parts together to prevent one part from turning is called a ______.

14. The method of making a sheet-metal pattern is called pattern development or making a ______.

15. To make a ¼" grooved seam it is necessary to add ______ inches of metal for the seam.

16. The material for a wire edge must equal ______ times the diameter of the wire.

17. The places where the metal is to be bent are shown on a sheet-metal drawing as________.

18. Boxes are made by the________ pattern development method.

19. The measuring tool used by the pattern maker is called a________ rule.

20. The taper on a wood pattern is called

21. The difference between the upper and lower limit shown on a machine drawing is called________.

22. Electrical drawings made with symbols are called________.

23. Christmas-tree lights that go out if one bulb is burned out are an example of________ wiring.

24. An example of________ wiring is the wiring system of a house.

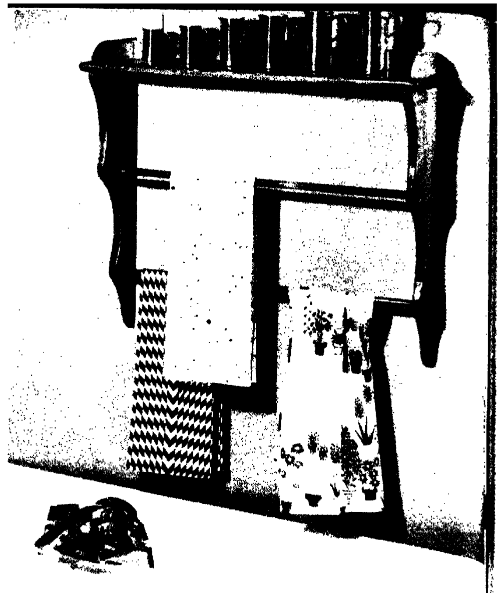
25. A layout for a printing job is called a________ view drawing.

26. The printer uses a special rule called a________, or type rule.

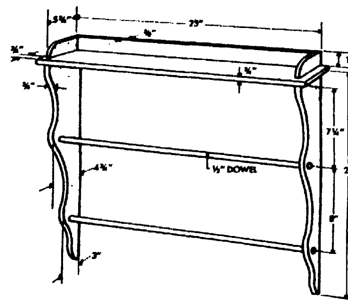
27. Plastics that can be heated and bent to change their shape are called________.

28. A process by which designs can be printed on cloth is called________ printing.

29. On simplified shop dawings,________ inch dots or circles can be used instead of arrowheads.

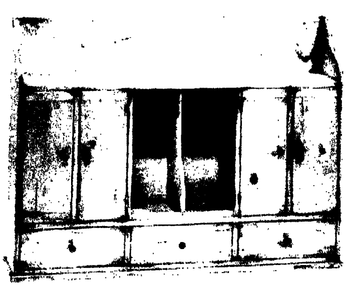


IV-A-3A



IV-A-3B

IV-A-4A



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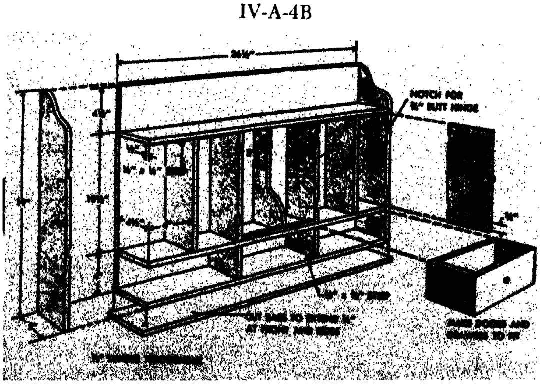
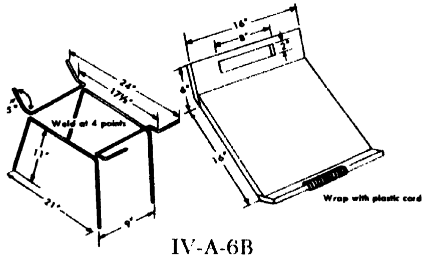
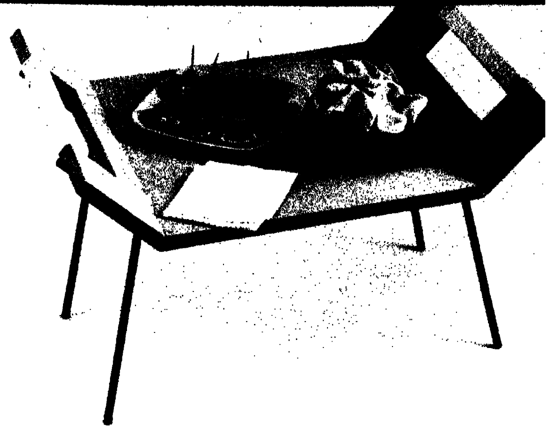


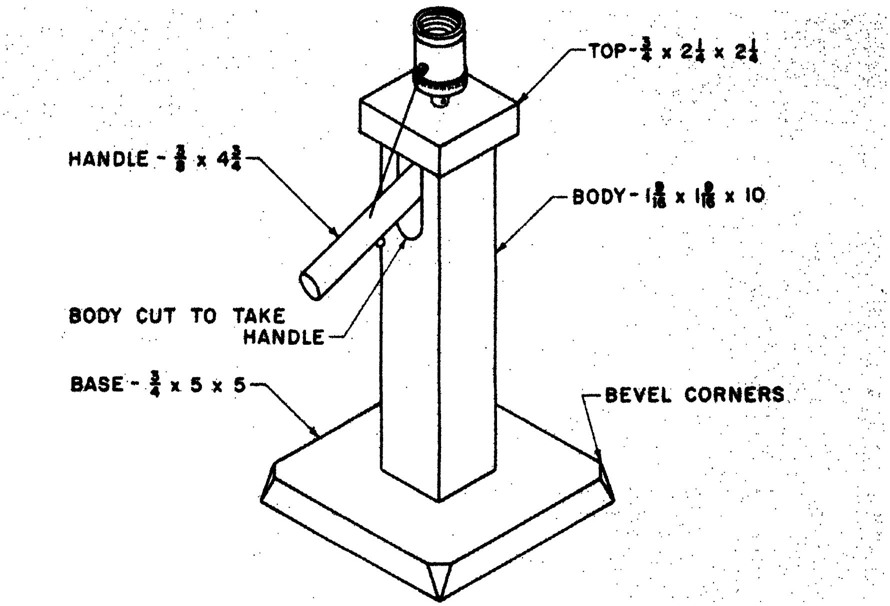


IV-A-6B



IV-A-6A

IV-A-7

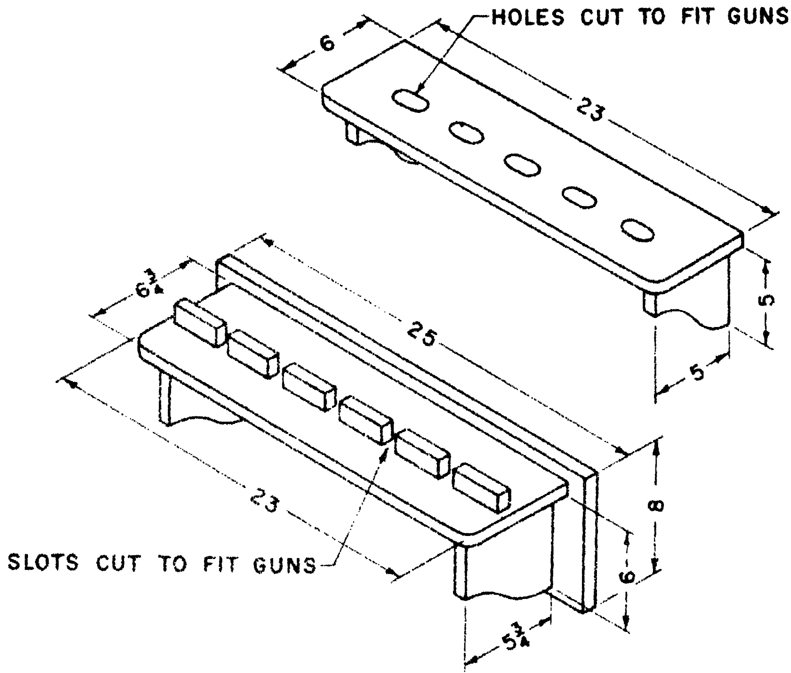


Section IV—APPLYING WHAT YOU HAVE LEARNED

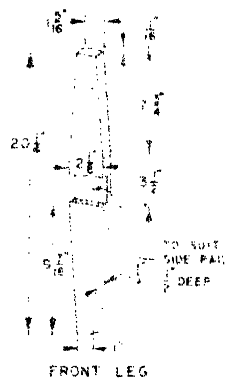
ACTIVITIES, THINGS TO DO, PROBLEMS, EXPERIENCES

A. Woodworking. Complete the following on either size A (8 ½" x 11") paper or size B (11" x 17") paper.

1. Make a full-size drawing of the cutting board. Fig. IV-A-1.
2. Make a full-size pattern for the child's chair. Fig. IV-A-2.
3. Complete a two-view working drawing of this towel rack and shelf. Fig IV-A-3.
4. Develop a three-view working drawing of this small cabinet. Fig. IV-A-4.
5. Make a detail drawing of each of the parts of this small vanity stool. Fig. 28-13.
6. Draw two views of this metal and wood table. Fig. IV-A-6.
7. Make a working drawing of this pump-handle lamp. Fig. IV-A-7.
8. Make a complete working (view) drawing of this gun rack. Fig. IV-A-8.
9. Make a two-view drawing of this front leg of a piece of furniture. Fig. IV-A-9.
10. Complete a working drawing of this stack block. Fig. IV-A-10. Figure the bill of materials for making six of these blocks.
11. Make a freehand sketch of wood saws.



IV-A-8



IV-A-9

12. Make a three-view drawing of a dado shown in Fig. 28-3. The stock is 1" x 4" x 8". The dado is ½" x 1" and is located 1" from the end.

13. Complete a three-view drawing of the drawer shown in the telephone stand, Fig. IV-A-13.

14. Make a cabinet drawing to some suitable scale of the night stand. Fig. IV-A-14.

15. Make an isometric drawing with dimensions of this record cabinet. Use the cutting plan to secure the measurements. Fig. IV-A-15. ¾" plywood

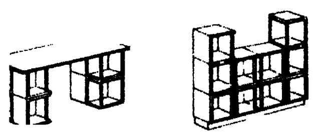
16. Make an angular perspective drawing of this toy cabinet. It is 30" high x 24" deep x 60" long. Use some suitable scale. Fig. IV-A-16.

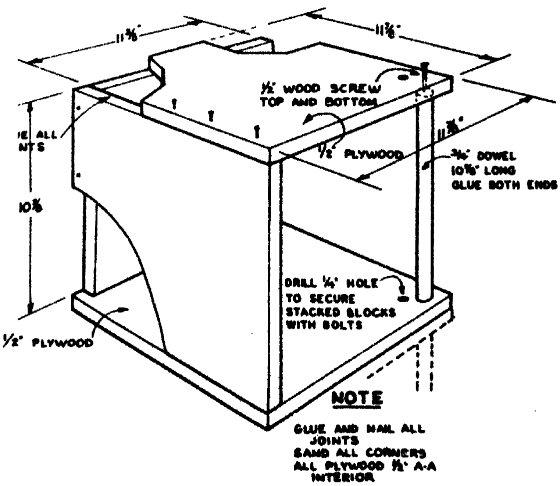
17. Complete a two-view working drawing of this tool rack to some suitable scale. Fig. IV-A-17.

18. Design a spoon rack and planter similar to the one shown in Fig. IV-A-18. Make the back about 12" x 20".

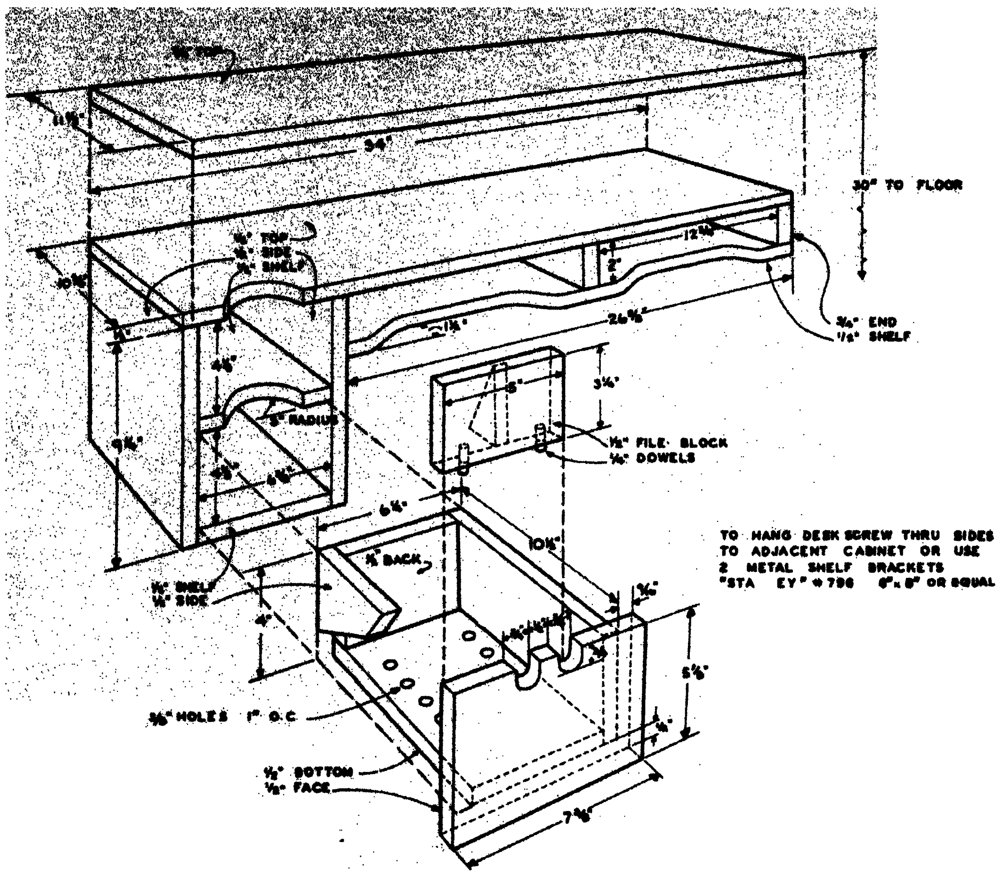
19. Complete a cabinet drawing of the coffee table shown in Fig. 28-12.

IV-A-10A

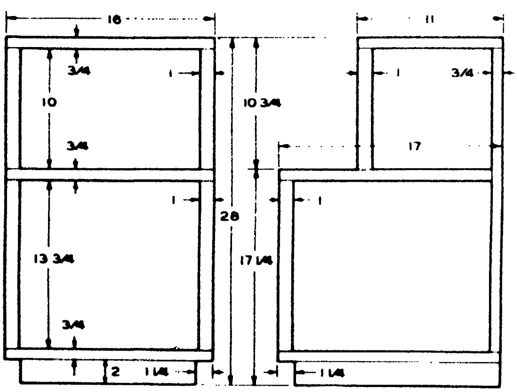




IV-A-10B



IV-A-13



IV-A-14

20. Make a bill of materials for the table shown in Fig. IV-A-19.

21. Design a gun case similar to the one shown in Fig. IV-A-20.

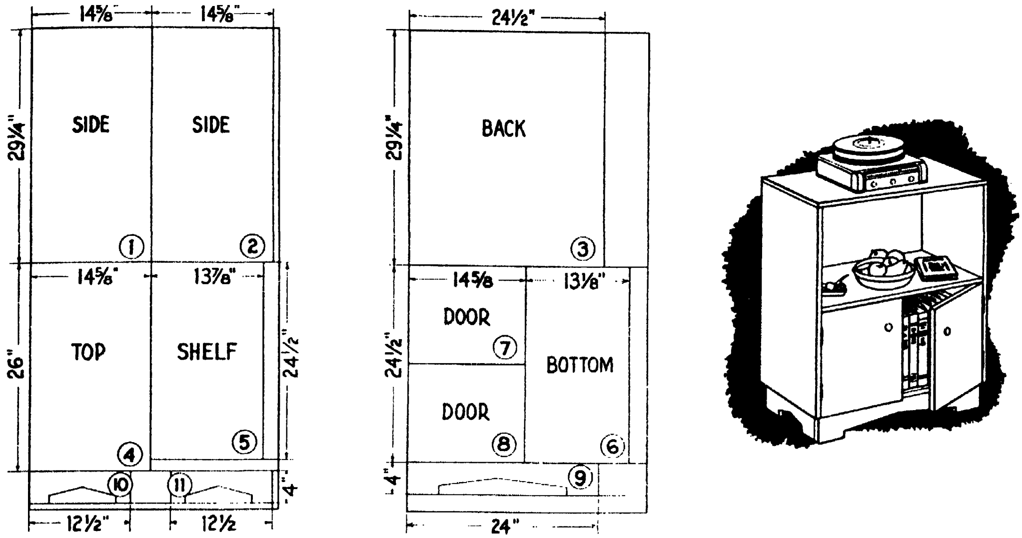
B. Metalwork

1. Draw two regular hexagonal head bolts similar to that shown in Fig. IV-B-1. Complete each to the following specifications: ½" diameter, ¾" width across the flats (F), 5/16" height of head (H), 2½" length, 1¼" length of thread. Add the regular symbol to one and the note showing 13 threads NC. Add the simplified thread to the other and the note showing 20 threads NF.

2. Draw a hexagonal head regular machin bolt to some desired size and add the thread symbols and note. Fig. 29-15. Use ASA bulletins or machinist handbook to secure the information. Fig. IV-B-2.

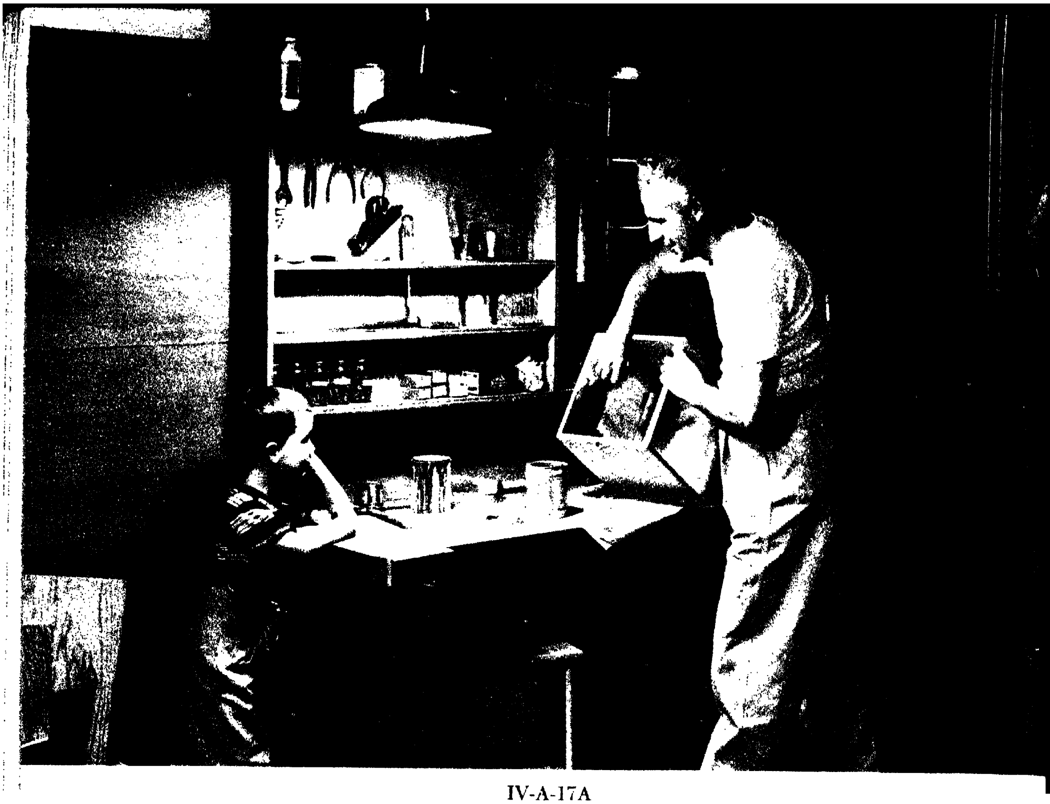
3. Fasten the two pieces of metal together with two 8-32 machine screws with round heads. The screws are 1" long. Fig. IV-B-3. Make a view drawing.

4. Make a drawing of the scriber in Fig. IV-B-4.

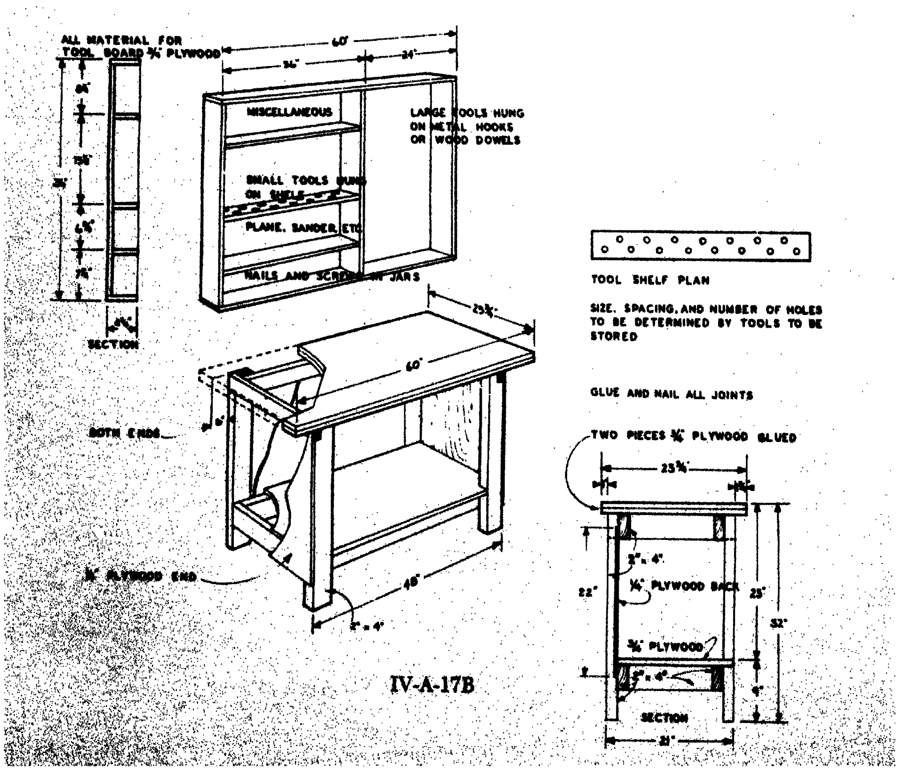

14⅝"
14⅝"
29¼"
SIDE
SIDE
1
2
24½"
29¼"
BACK
3
14⅝"
13⅞"
26"
TOP
SHELF
4
5
24½"
10
11
4"
12½"
12½
14⅝
13⅛"
DOOR
7
24½"
BOTTOM
DOOR
8
6
4"
9
24"

IV-A-15

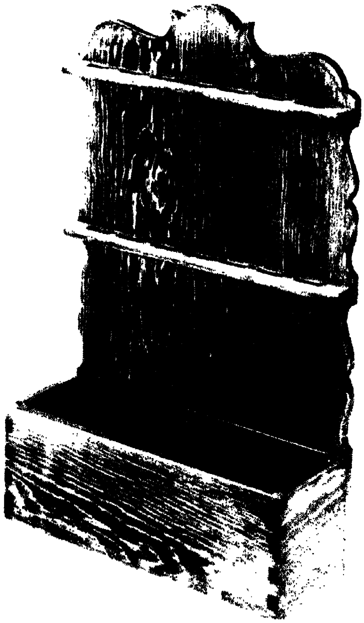
IV-A-16



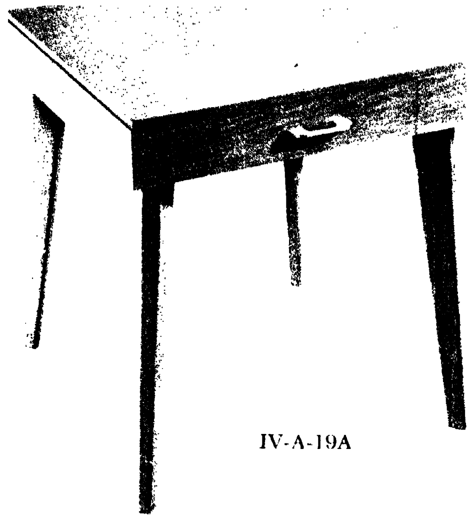
IV-A-17A



IV-A-17B

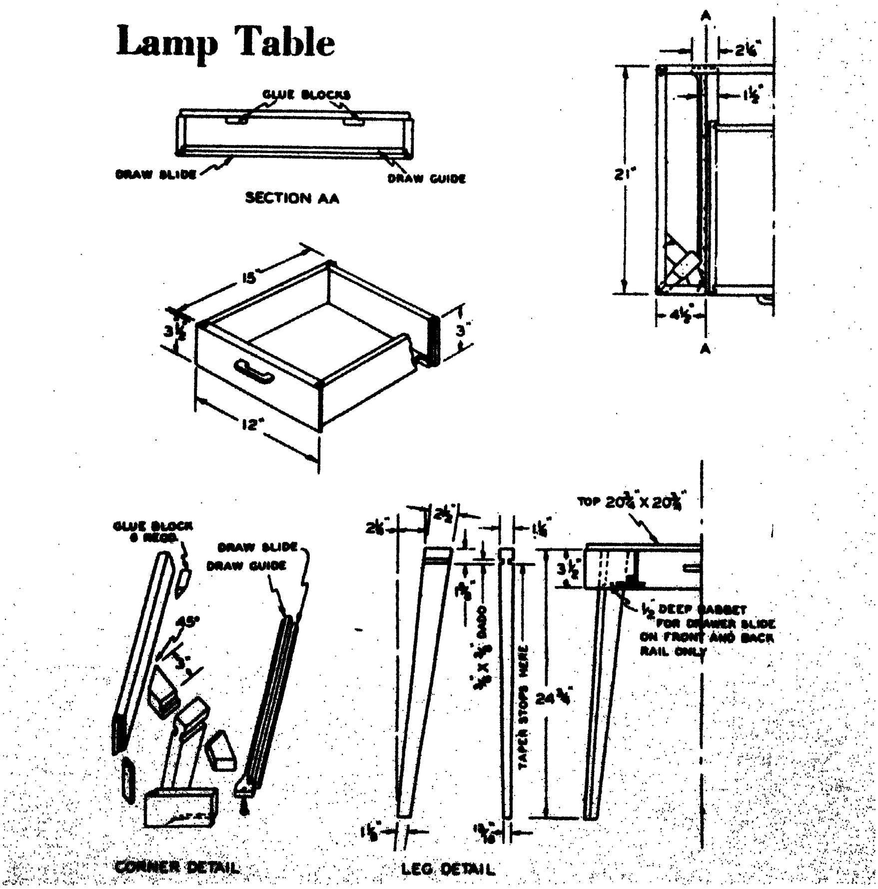


IV-A-18

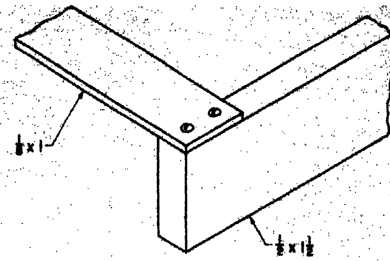


IV-A-19A

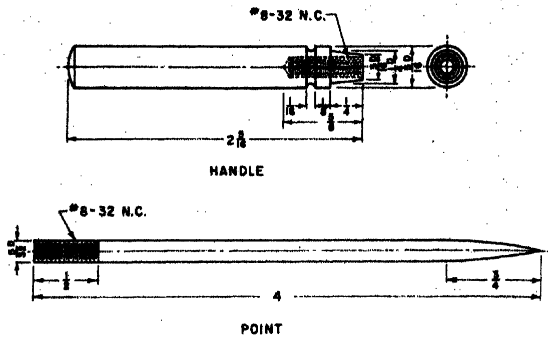
IV-A-19B



IV-A-20

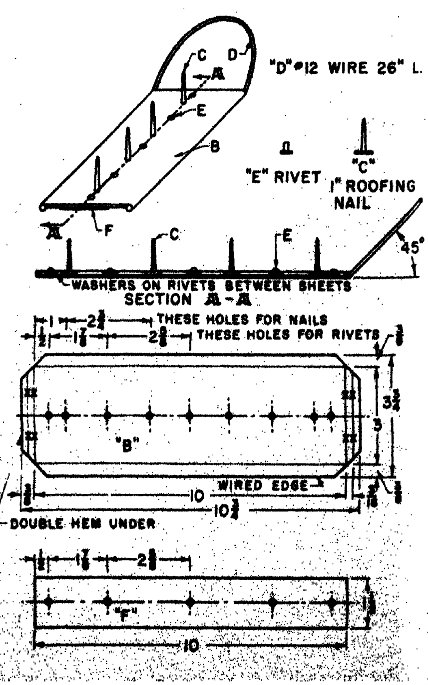


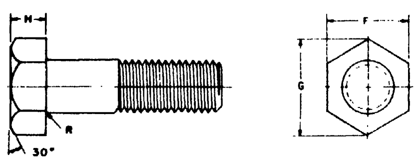
IV-B-3



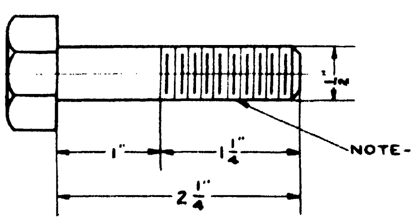
IV-B-4

IV-B-10





IV-B-1

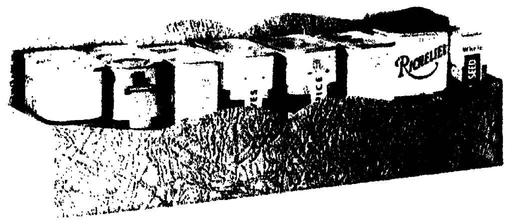


IV-B-2

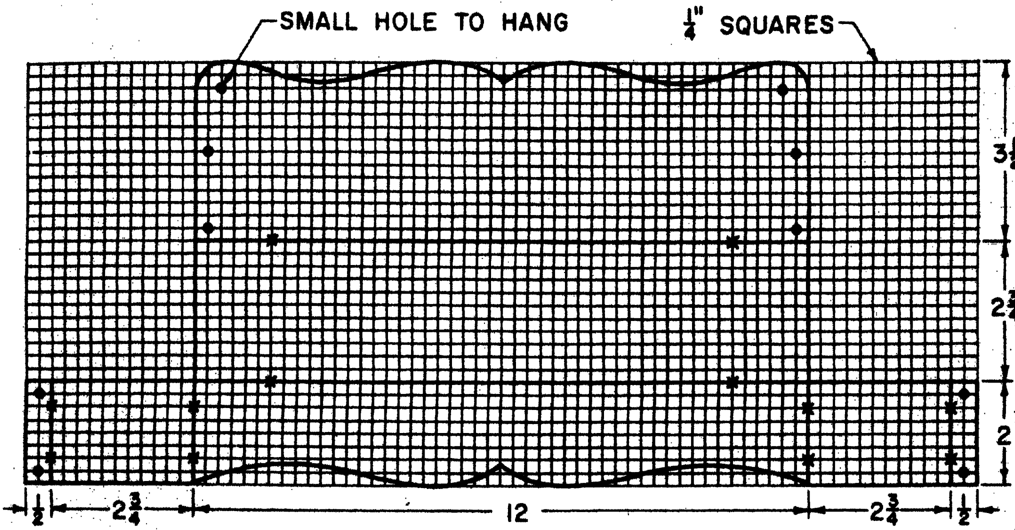
5. Complete an assembly drawing of the scriber shown in Fig. 18-5.

6. Make a freehand sketch of four of the common hand tools used in bench-metal work. Fig. 29-1.

7. Make a detail drawing to some suitable scale of the parts of the tie rack shown in Fig. 29-26.



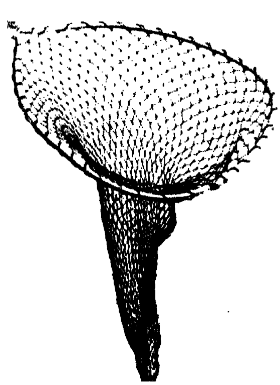
IV-B-11A



IV-B-11B

8. Make a full-size pattern for the scoop shown in Fig. 29-34.

IV-B-12A



9. Develop a full-size pattern for a funnel that has the following measurements: A = 5"; B = 6", C = ¾", D = 2", and E = ½". Fig. 29-36.

10. Complete a full-size pattern for each part of the potato baker shown in Fig. IV-B-10.

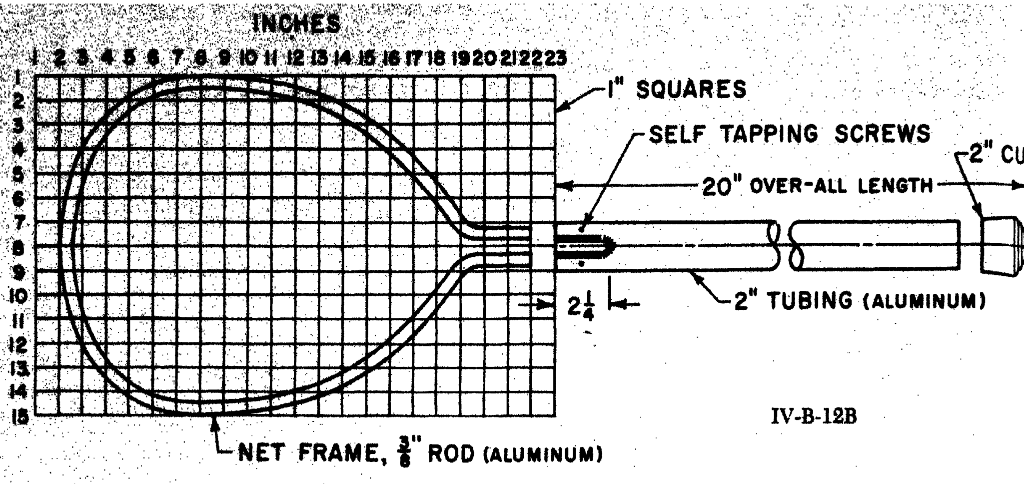
11. Make a pattern that is full size for the spice rack shown in Fig. IV-B-11.

12. Make a full-size pattern for the net frame and a scale drawing of the handle of the fishing net shown in Fig. IV-B-12.

13. Complete the full-size patterns for the small change box shown in Fig. IV-B-13.

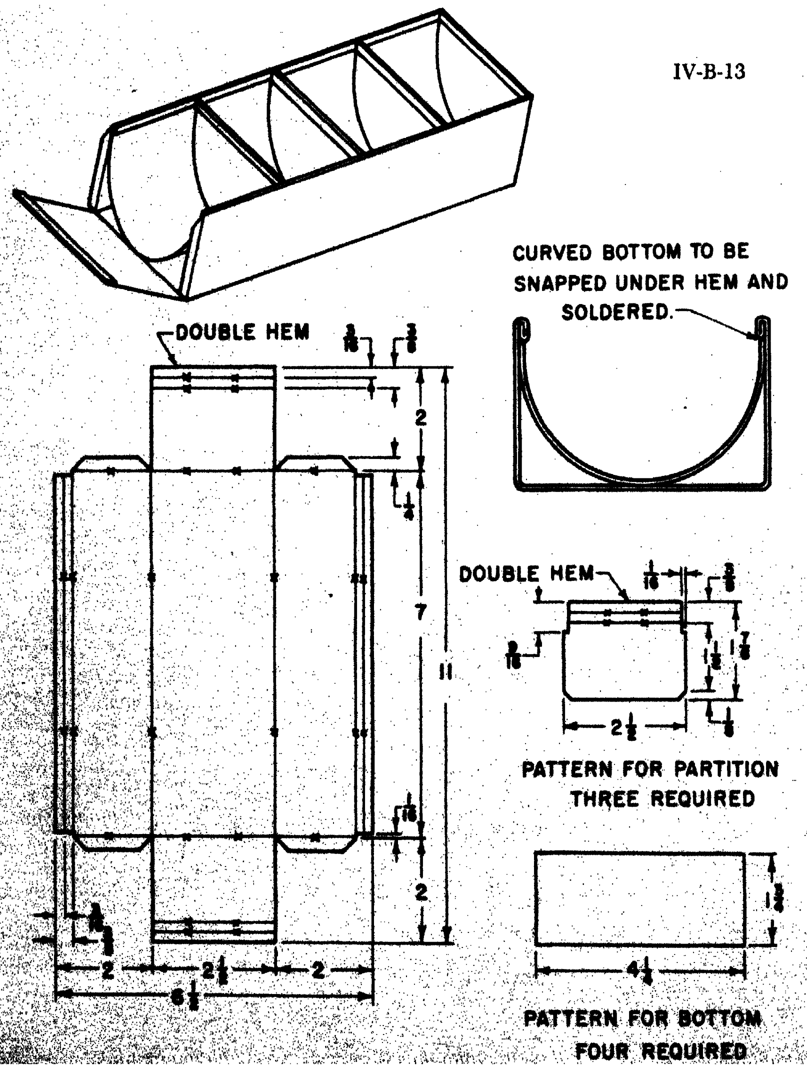
14. Develop the full-size pattern for the mailbox. Fig. IV-B-14.

15. Make a three-view drawing to some suitable scale of the occasional table you



IV-B-12B

IV-B-13



see in Fig. IV-B-15. A = 12⅜", B = 22", and C = 50".

16. Develop a pattern for a wall plaque such as is shown in Fig. IV-B-16. This plaque is to be made of thin copper or aluminum. The design is tooled in the surface.

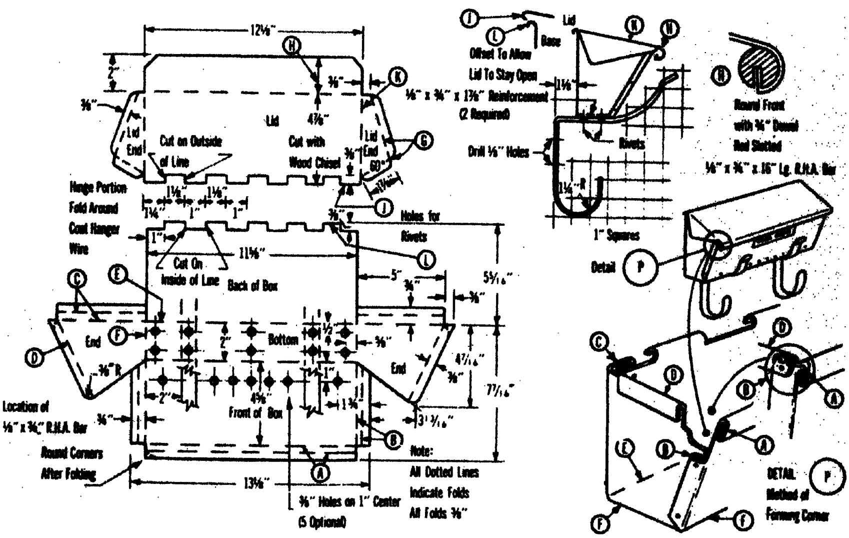
17. Design a small dish made from a 6" piece of 18-gauge copper. Fig. 29-41.

18. Develop a candle sconce such as is shown in Fig. IV-B-18. Measure the size of a candle and design the project around it.

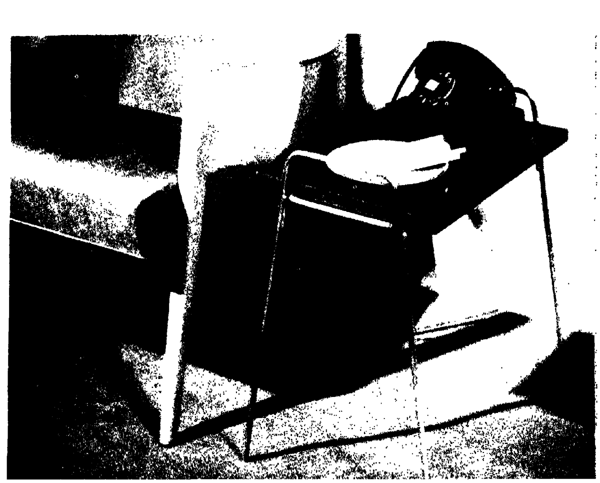
19. Develop a design for an art-metal tray that is 12" in diameter. Fig. IV-B-19.

20. Make a full-size pattern for the planter lining shown in Fig. IV-B-20. Add a ½" lap seam on each corner.

IV-B-14A



IV-B-14B

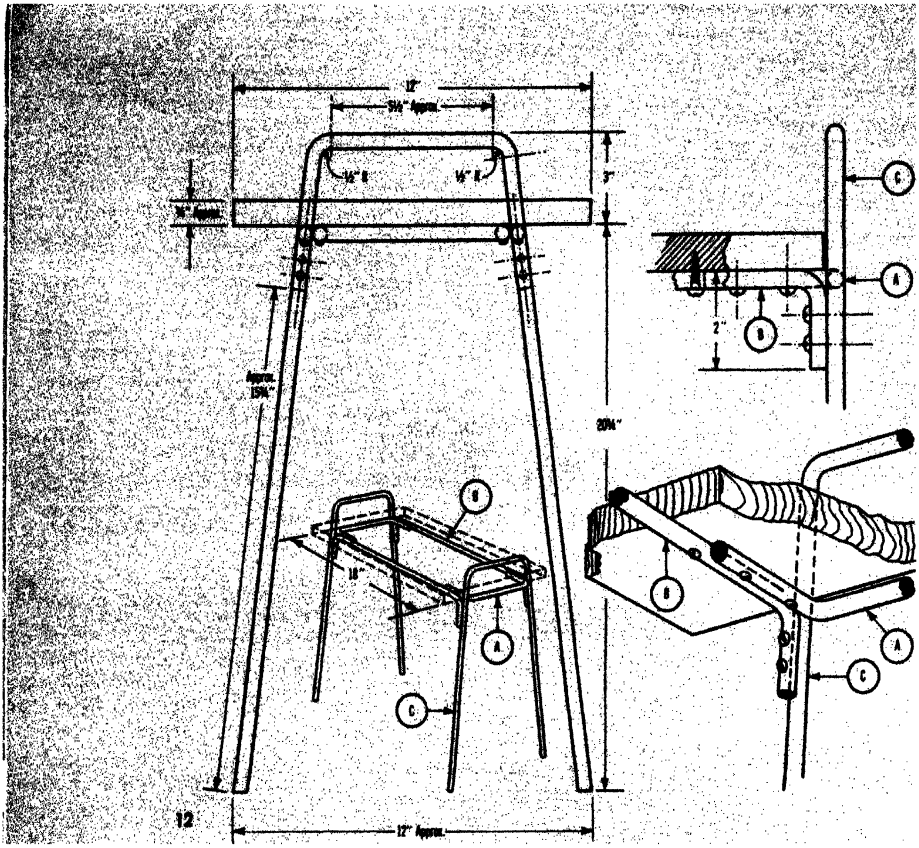


IV-B-15A

21. Make an assembly drawing of the screw driver shown in Fig. IV-B-21.

22. Complete detail drawings of each part of this fly-tying vise. Then make an assembly drawing. Fig. IV-B-22.

23. Make an isometric drawing of the riveting hammer head. Fig. II-B-11.

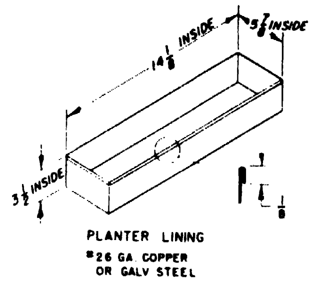


IV-B-15B

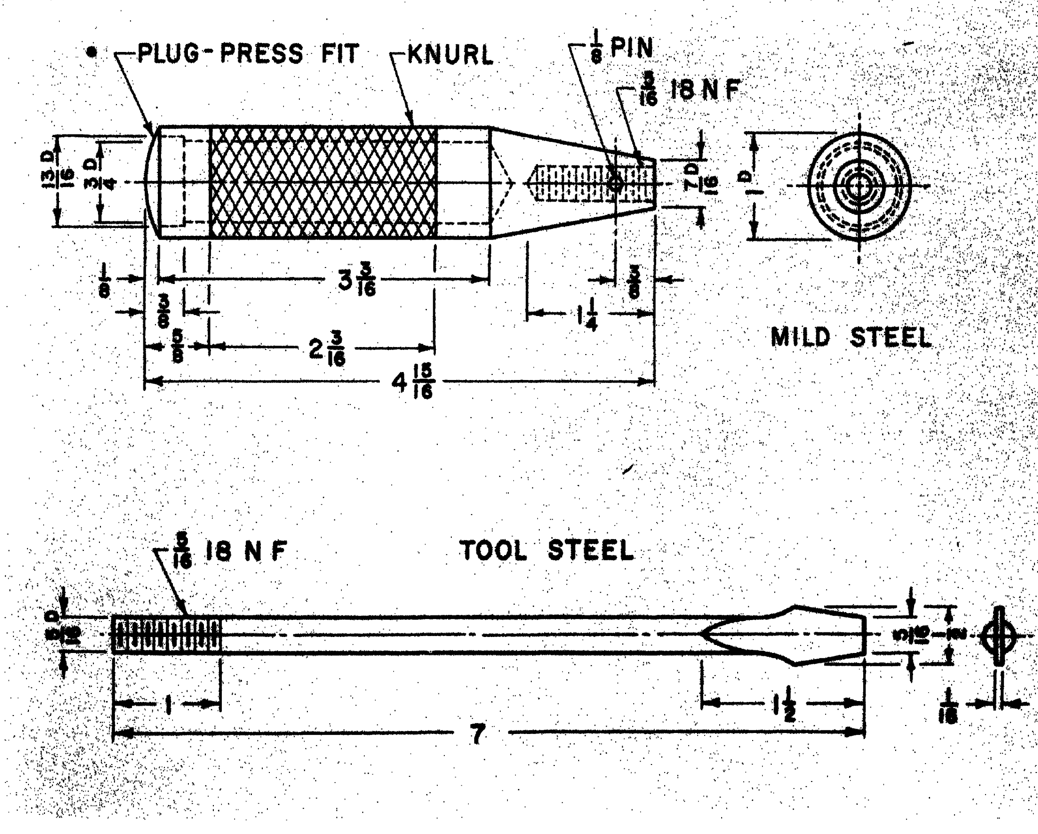
IV-B-16

IV-B-18

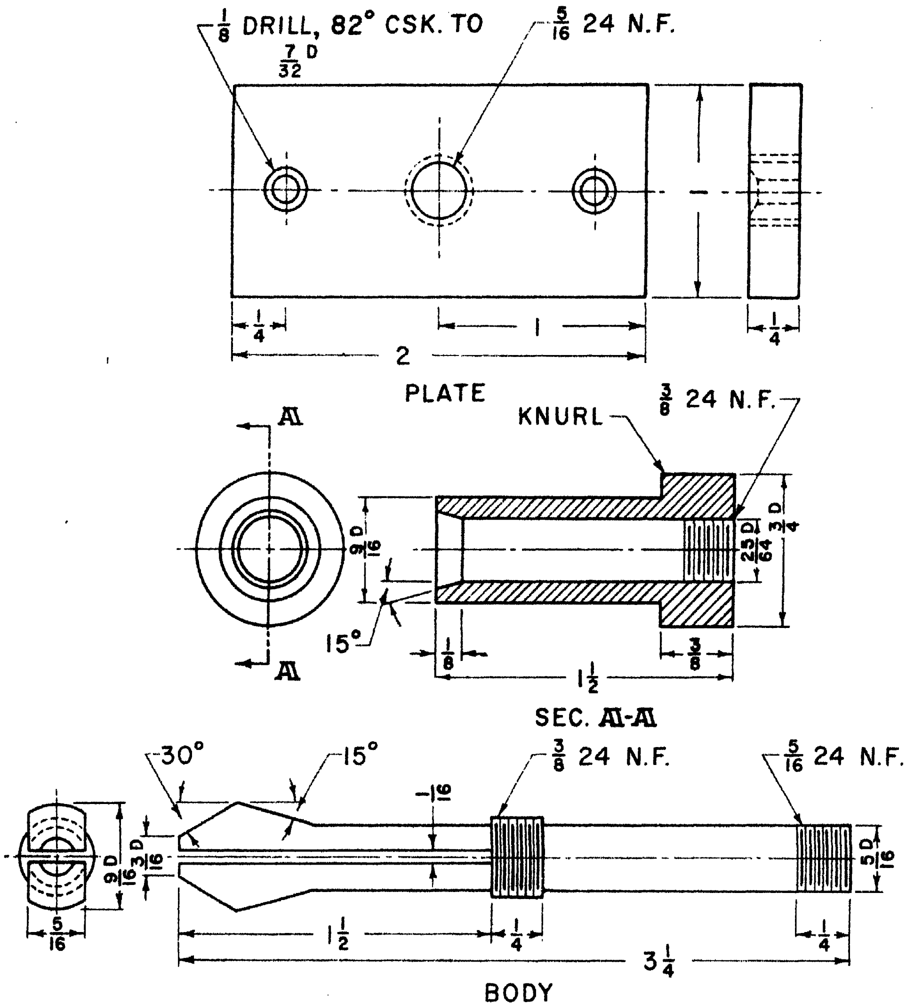
IV-B-19



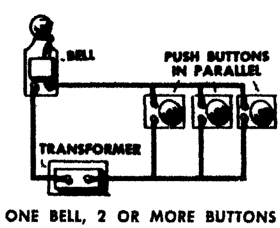
IV-B-20



IV-B-21

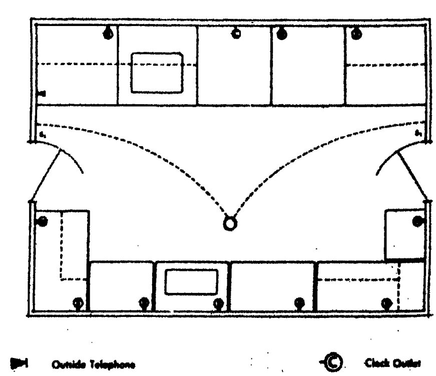


IV-B-22

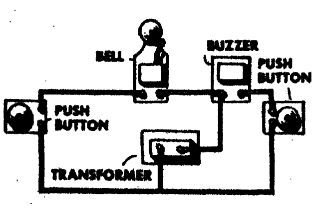


ONE BELL, 2 OR MORE BUTTONS

IV-C-3

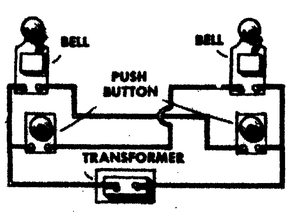


IV-C-7



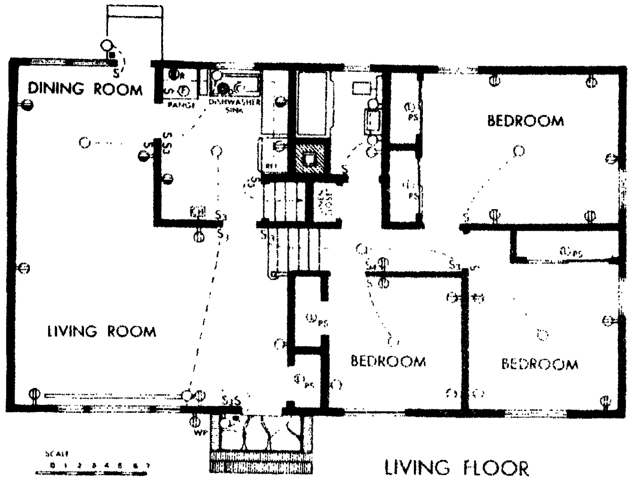
FRONT BELL-BACK BUZZER

IV-C-4

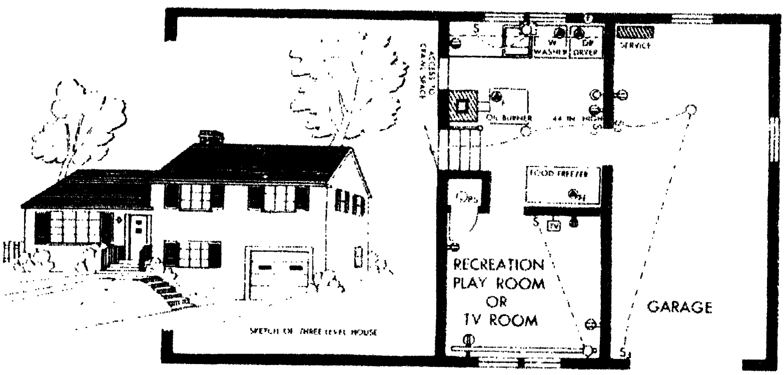


SIGNAL & ANSWER SYSTEM

IV-C-5



LIVING FLOOR
FIRST AND SECOND LEVELS



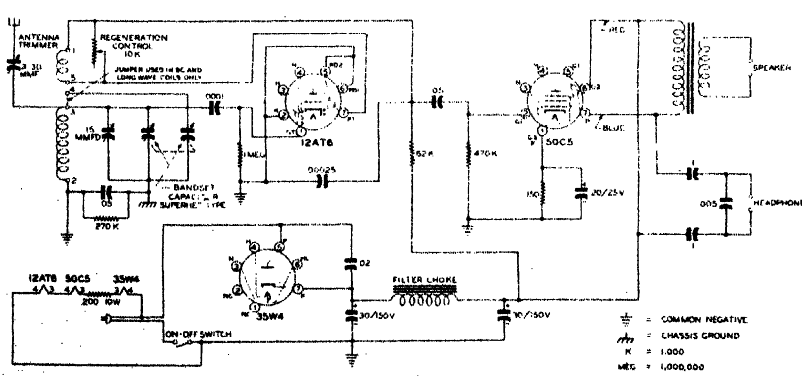
Duplex Convenience Outlet – Split Wired

Special-Purpose Outlet. Use subscript letters to indicate function. DW-Dishwasher, CD Clothes Dryer, etc.

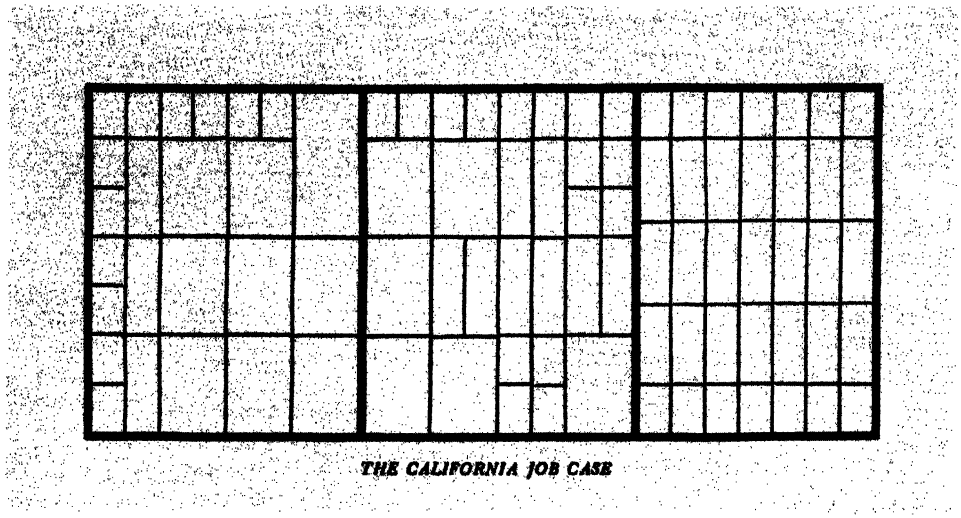
BASEMENT

IV-C-8

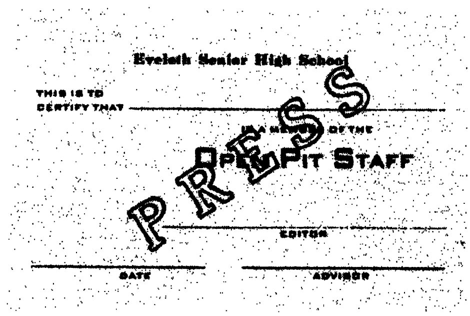
IV-C-11



SCHEMATIC DIAGRAM
OCEAN HOPPER 740



IV-D-1



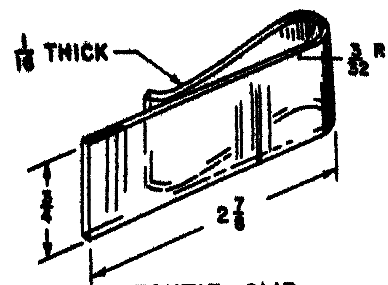
IV-D-4

C. Electricity Problems

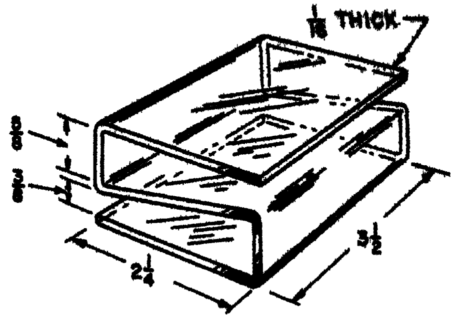
1. Draw the symbols for the common electrical devices for low-voltage wiring. Fig. 30-2.
2. Draw a schematic of a simple circuit: bell, push button, wire, and transformer. Fig. 30-4.
3. Complete a schematic of a circuit with one bell, a transformer, and three push buttons in parallel. Fig. IV-C-3.
4. Make a schematic drawing for a bell and buzzer system for a home. A bell operates from a front door push button and a buzzer from the back door. Use one source of power—a transformer for both. Fig. IV-C-4.
5. Draw a schematic of a return call or signal and answer system. You may use such a system between the house and garage, workshop, or barn. Fig. IV-C-5.
6. Draw the common symbols used in house wiring. Fig. 30-8.
7. Make a scale drawing and an electricity layout for this kitchen. Fig. IV-C-7.
8. Draw the floor plans for the house in Fig. IV-C-8, and add the wiring diagram.
9. Draw the symbols used in radio work. Fig. 30-15.
10. Make a schematic diagram of the crystal set. Fig. 30-14.
11. Complete a schematic diagram for the radio shown in Fig. IV-C-11.
12. Make an assembly and detail drawing for the small motor in Fig. 30-16.
13. Make a floor plan of your own home and show how you would rewire it.

D. Graphic Arts and Printing

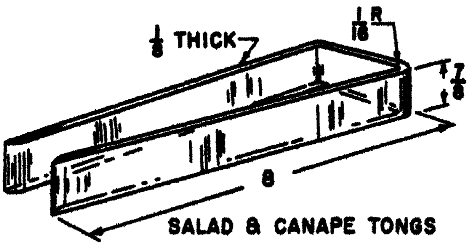
1. Make a layout of this California job case and letter in the correct information on the locations of the type. Fig. IV-D-1.
2. Make a layout for a football ticket, including the name of the schools participating, the date, the location, and the cost per ticket.



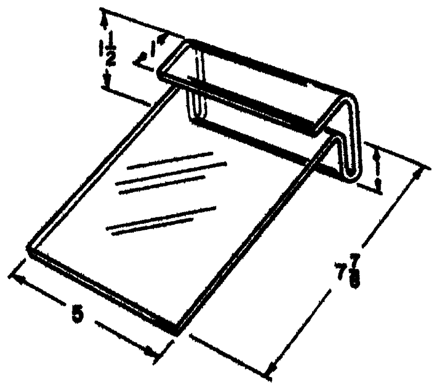
NECKTIE CLIP



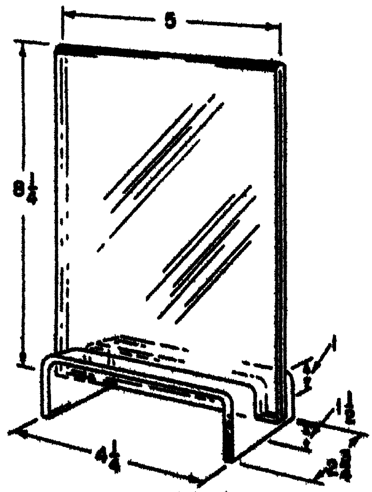
PLAYING CARD HOLDER



SALAD & CANAPE TONGS

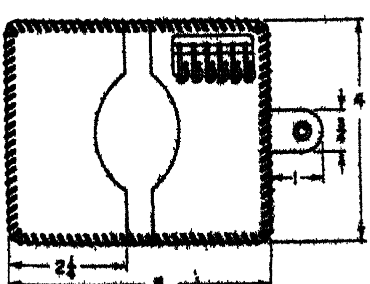


PAD HOLDER



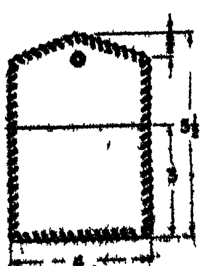
PHOTOGRAPH FRAME

IV Γ 1



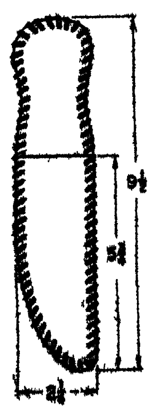
KEY CASE

IV-E-2A



NOTE HOLDER

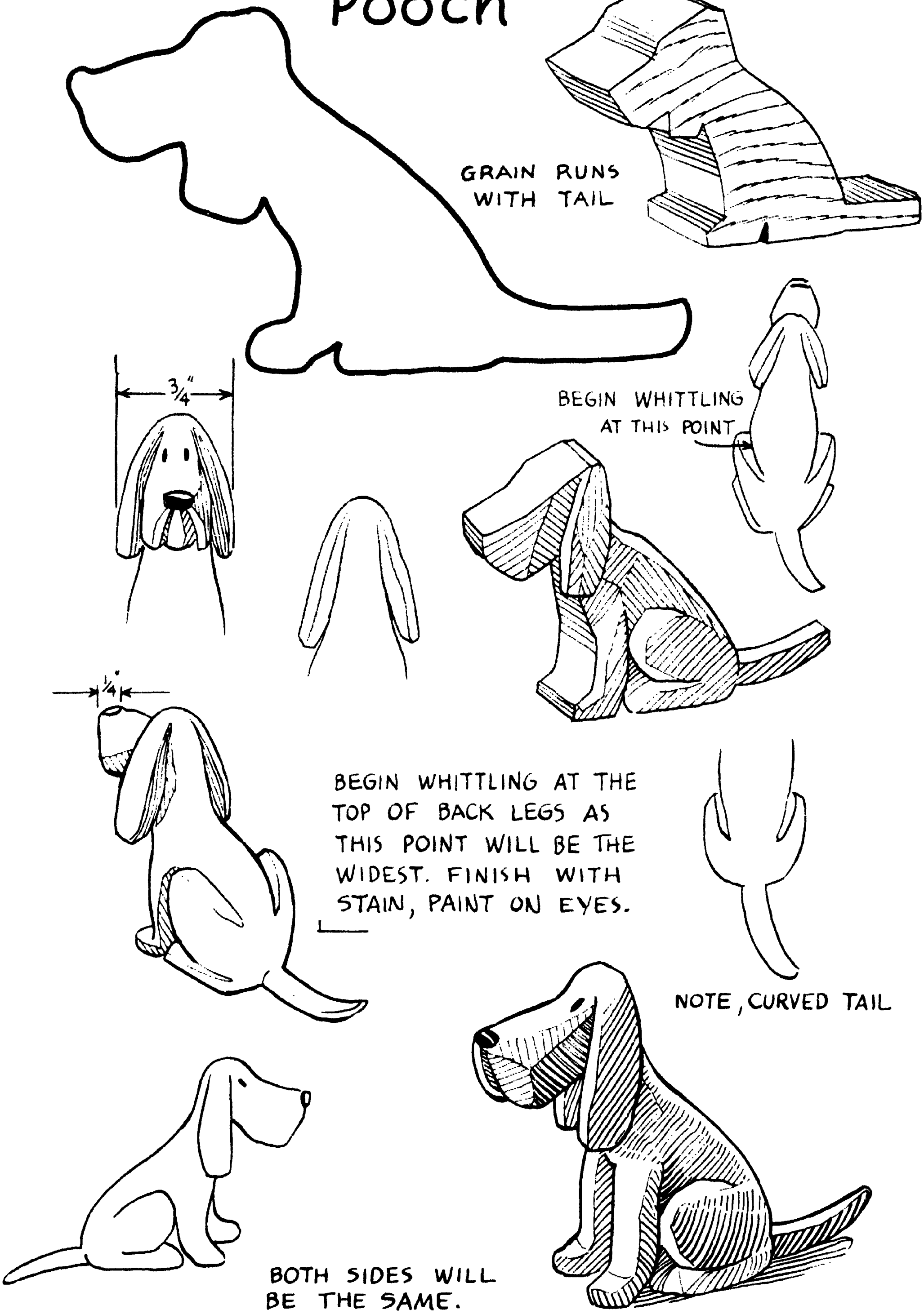
IV-E-2B



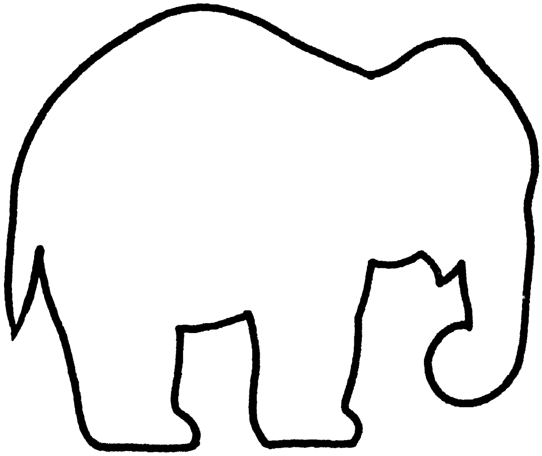
SHEATH

IV E 2C

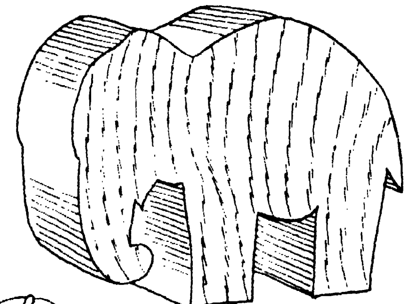
Pooch


GRAIN RUNS WITH TAIL
3/4"
BEGIN WHITTLING AT THIS POINT
1/4"
BEGIN WHITTLING AT THE TOP OF BACK LEGS AS THIS POINT WILL BE THE WIDEST. FINISH WITH STAIN, PAINT ON EYES.
NOTE, CURVED TAIL
BOTH SIDES WILL BE THE SAME.

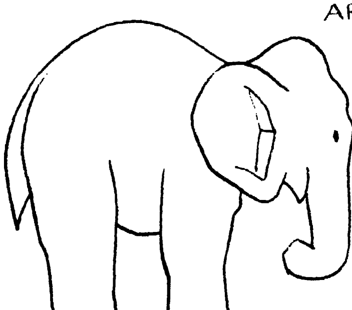
Jumbo

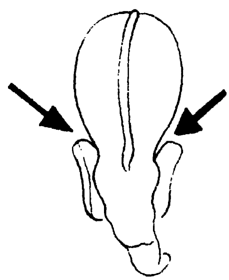


USE 1¼" THICK WOOD, PLACE ON BLOCK WITH GRAIN VERTICAL



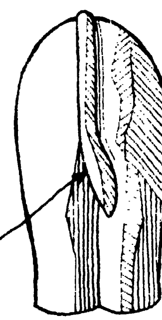
BEGIN WHITTLING AT POINTS MARKED WITH ARROWS

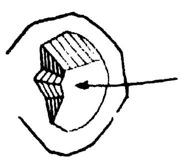




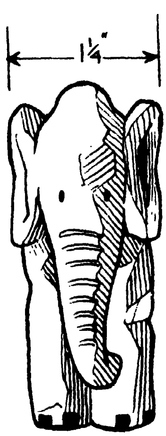
BOTH SIDES WILL BE THE SAME.

NOTE, CURVE IN TAIL

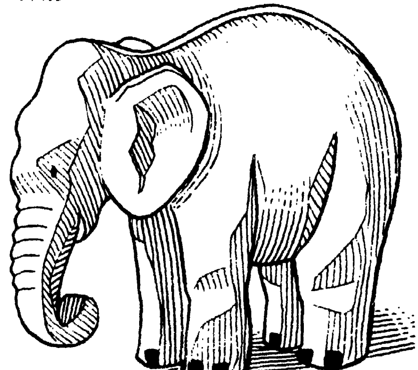




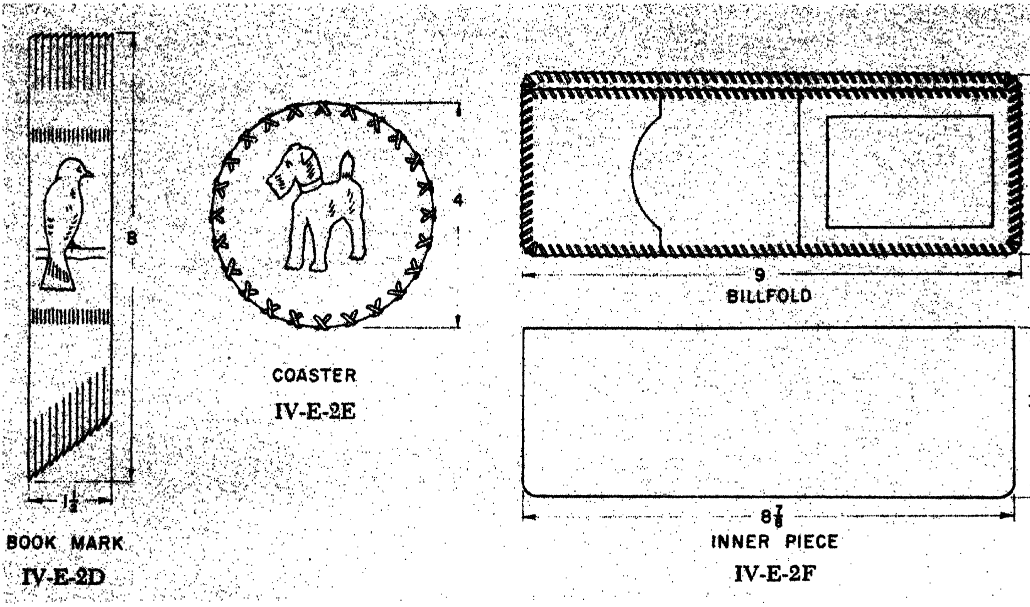
3/4 DEEP AT THIS POINT



FINISH BY PAINTING WITH A MIXTURE OF BLACK & WHITE. DO NOT VARNISH.



THREE BLACK TOE-NAILS ON EACH FOOT



BOOK MARK
IV-E-2D
COASTER
IV-E-2E
INNER PIECE
IV-E-2F

gram.

4. Make a layout for a membership card in a club, such as shown in Fig. IV-D-4.

5. Design a linoleum-block for a Christ-

E. Arts and Crafts

1. Make a working drawing including flat-pattern layouts for any of the following plastic projects (Fig. IV-E-1):

a. Cigarette box. Fig. 32-3.
b. Salad and canape tongs.
c. Photograph frame.
d. Necktie clip.
e. Playing-card holder.
f. Pad holder.

2. Make a full-size pattern for any of the following leather projects (Fig. IV-E-2):

a. Key case.
b. Note holder.
c. Sheath.
d. Bookmark.
e. Coaster.
f. Billfold.

3. Design an arm guard and a tab finger guard for an archery outfit. Fig. 32-6.

4. Make a full-size pattern for the wood carvings (Fig. IV-E-4):

a. Pooch: 3⅜" x 6".
b. Jumbo: 3¼" x 4¼".

Section V
LIFE ACTIVITY DRAWING

HERE are the things you will learn in life activity drawings . . . what you should know and be able to do after you have studied the units in this section:

1. Architectural drawings, or drawings of building.
2. How to make a room or shop layout.
3. A home addition and how to plan and carry it through.
4. How to plan a remodeling job.
5. Home planning.
6. Built-ins.
7. The many different kinds of maps.
8. Graphs and charts.
9. How to make several kinds of graphs and charts.

Section V

34. Building Drawings

Drawings of buildings in which people live and work and where materials are stored are called *architectural* drawings. This is a very special kind of drawing done by architects. Architects have at least four or five years of college training and several years of experience. You should not expect to design and draw complete architectural plans yourself, but you can learn something about planning and designing a home. It is very helpful to know how to make preliminary plans for such things as a new cabin or house or an addition to a home. Most important, you can learn how to read house plans.

Building construction is one of the largest industries in our country. There are more people employed in skilled trades in building construction than in any other area of activity. There are more than fifteen specialized, skilled building trades. Some of these people, like the carpenter, mason, bricklayer and plumber, are men you know personally. If you become interested in any profession or trade in the building industry, you will need to learn a good deal more about making and reading architectural drawings.

MAKING A ROOM ARRANGEMENT OR SHOP LAYOUT

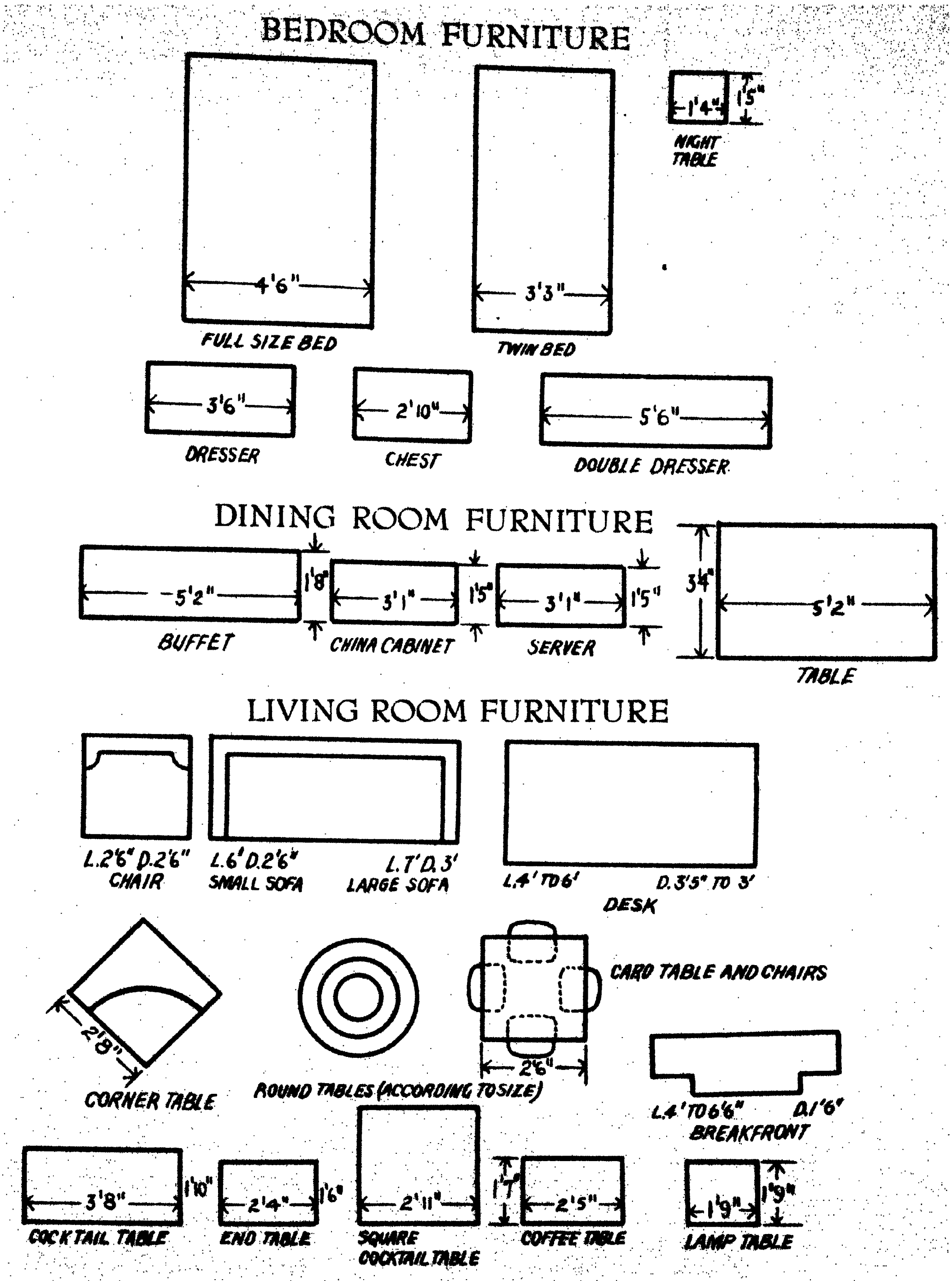
A very simple kind of architectural drawing is a room arrangement. Suppose you have built or bought a new piece of furniture for your room. You will want to arrange it without actually moving all the furniture around several times. You can do the following:

1. Select a piece of squared or cross section paper that has four or eight squares to the inch. Follow a scale of ¼″ to the foot to make your drawings.

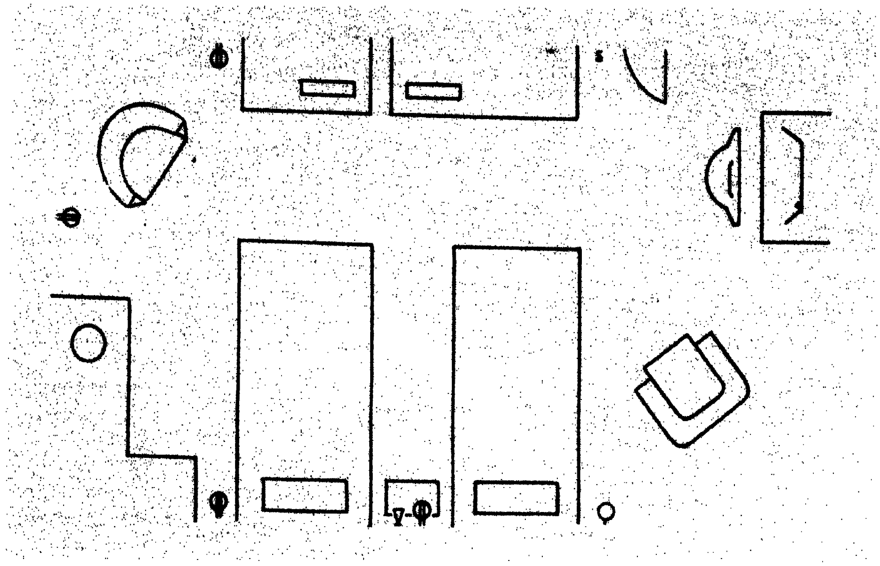
2. Measure your room to find its overall size. Draw the outline of the room on the paper. Show all the doors and windows to the proper scale.

3. Make cutouts or templates to scale of all the pieces of furniture. Fig. 34-1 shows the cutouts for many pieces of furniture. Draw these on cardboard. Letter in the name of each one and cut them out.

4. Place the cutouts on the room outline. Consider what the room is to be used for. Move the cutouts around several times until you find a satisfactory arrangement. Remember that the plan is a view of the



34-1. Common sizes of furniture to use in making templates. Scale is $\frac{1}{4}'' = 1'$.



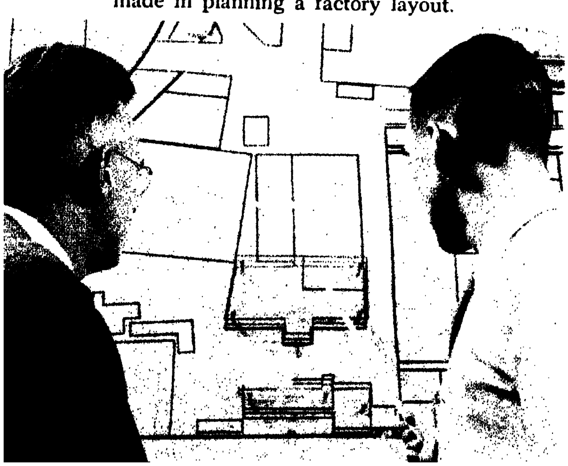
34-2. Here is a typical plan view of a bedroom.

room as you look at it from above. Be sure to put in the doors and windows. Fig. 34-2.

5. When you have a good arrangement, attach the cutouts to the outline with rubber cement.

6. This kind of planning is done in schools and industries for making layouts of shops and factories. Fig. 34-3. You can do it to plan a home workshop in an area in your basement or garage. Measure the size of the area you will have. Make drawings of it to scale. Show all the openings like doors and windows and any objects that might interfere with the arrangement such as pipes, drains or meters. Make the cutouts for machines and benches you are going to have in the workshop. Also make cutouts for the machines you might buy later. Arrange these cutouts considering the following: aisles of traffic clearance for the materials to be used, safety zones around machines, and the best place for lights.

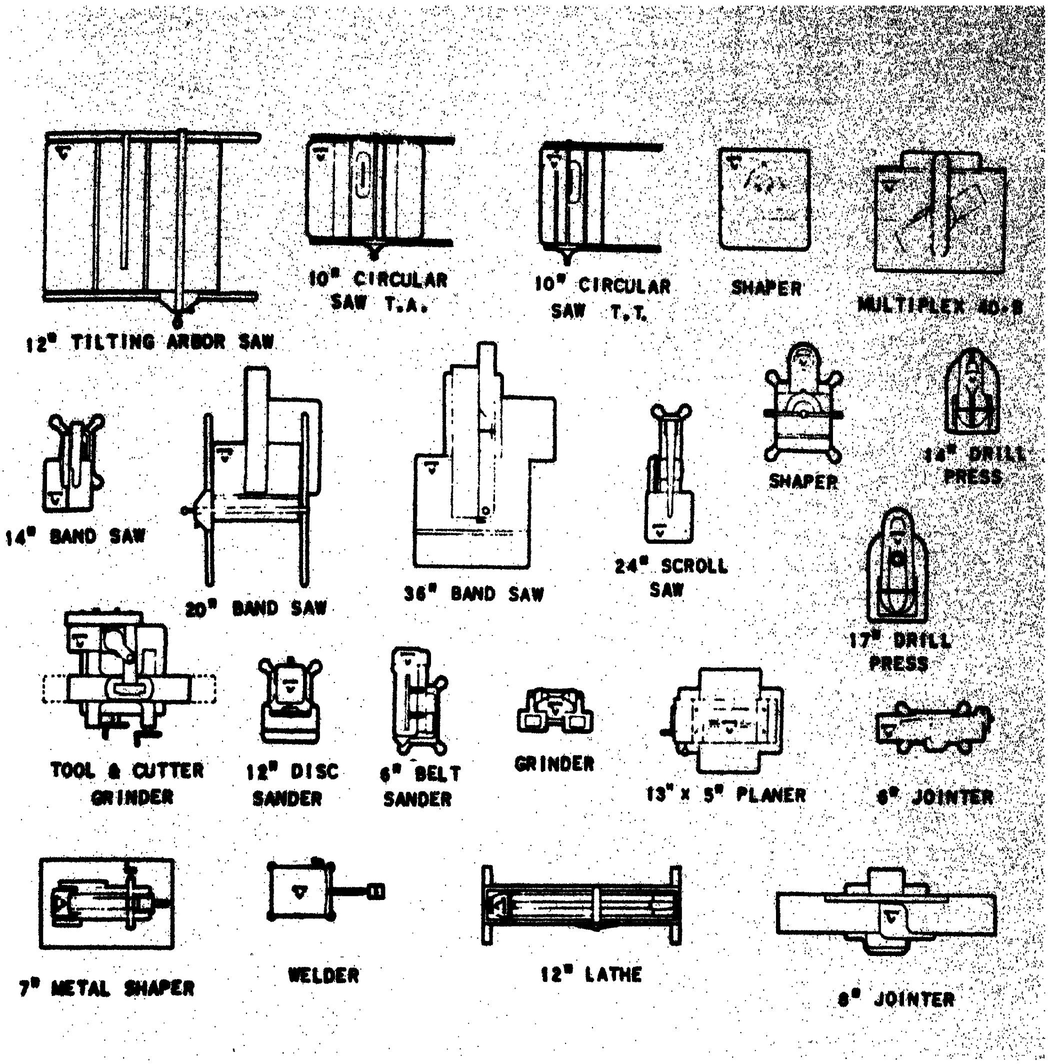
34-3. This is the kind of drawing that is made in planning a factory layout.



Here are the cutouts for the common machine tools. Fig. 34-4. This is an example of a home-workshop plan. Fig. 34-5.

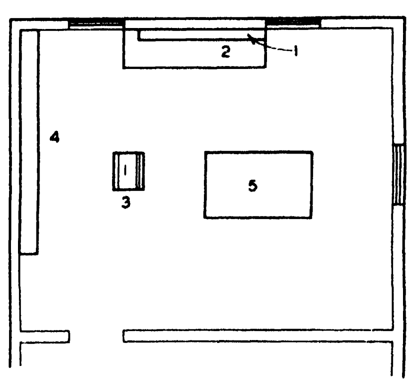
PLANNING AN ADDITION

Often a house is not big enough

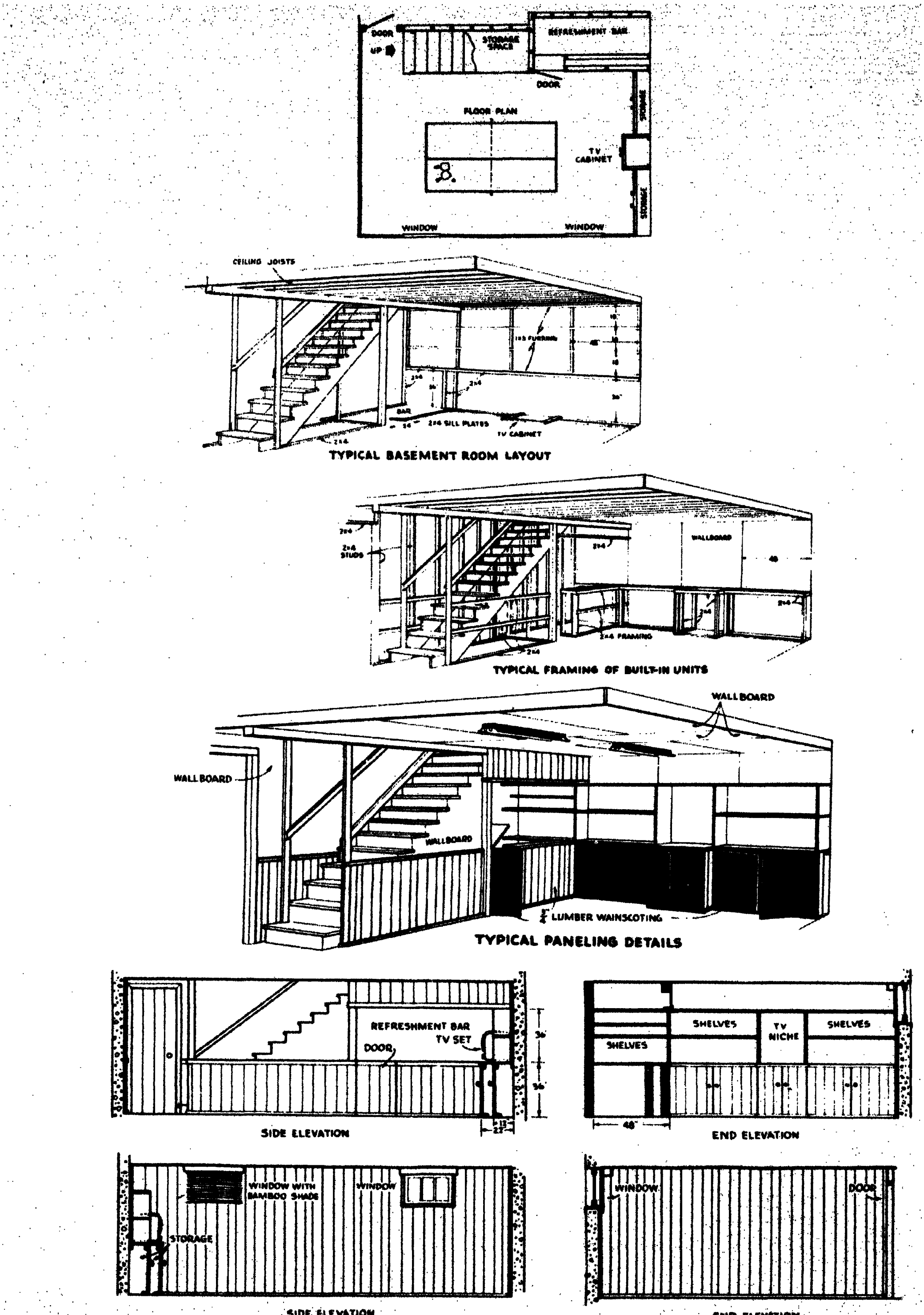


34-4. Templates for common power tools. Scale: ¼″ = 1″.

for a growing family. Suppose a family wants to plan an activity room in the basement, add a garage, enclose a porch, or finish a bedroom in the attic. Fig. 34-6. This is a good



34-5. This is an example of a layout for a simple home workshop: 1. Tool storage. 2. Work bench. 3. Circular saw. 4. Storage. 5. Machine bench for jig saw, jointer, drill press and grinder.



34-6. Here you see a suggested "how to do it" guide for building a basement recreation room. Since basements vary so much, no attempt is made to show exact dimensions or location of room details.

chance to become acquainted with architectural drawing.

If the room is to be finished inside the house, you will already know its size by measuring the space. If it is to be outside the house like a porch, extra room or garage, you will need to know the size of the addition and its location. Rooms vary so much in size that it is difficult to give any specific measurement. It depends on what the room is to be used for. The best idea is to make a floor plan and then discuss it with the others in the family. This rough plan should be drawn to scale on squared paper.

Make the floor plan as follows:

1. Measure the area to be included in the new addition.

2. Decide on the scale to follow. Usually a scale of ½" to 1' or ¼" to 1' is used. Fig. 34-6.

3. Draw the outline of the room or addition.

4. Locate all openings such as windows and doors. Draw these to scale.

5. Draw in any obstructions such as chimneys, walls and pipes.

6. Draw in any partitions such as closets or cabinets.

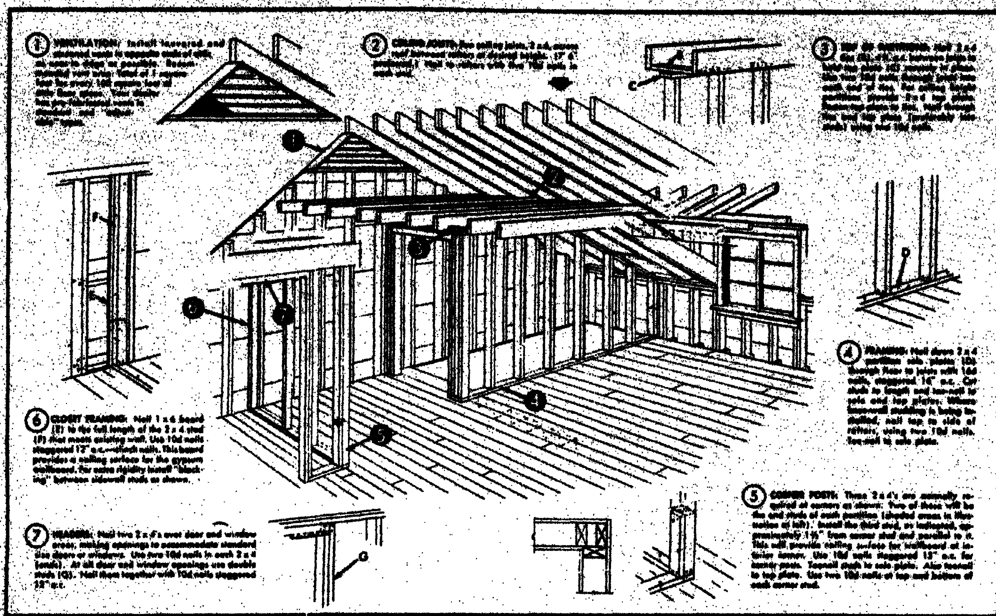
7. Darken in the outline.

8. Add the dimensions.

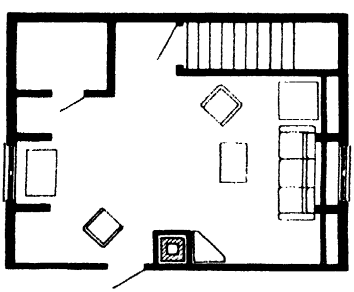
After you have decided on the exact size and shape, you can take the rough drawing to a lumber yard. Here an architect or building consultant will make a more detailed plan for you. He will also help you to decide on the materials you need. Fig. 34-6.

To illustrate the steps in planning and building an addition, the following describes how to add an extra bedroom in the attic or unfinished

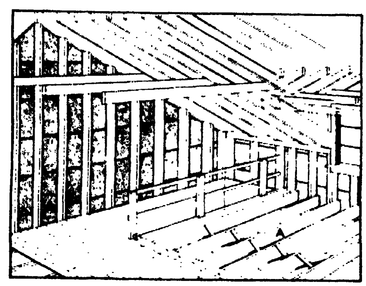
34-7. The finished bedroom described in the following section.



34-8. Common terms used in building construction.

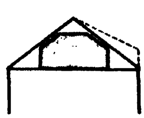


34-9. The floor plan.



34-11. Sub-flooring.

34-10. Room area shown in black.



second floor. Fig. 34-7. This will also help you to get acquainted with some common terms used in building construction. Fig. 34-8.

Anyone who can hammer a nail, handle a saw, or wield a paint roller

can make this room or one similar to it. The room shown here is a typical unfinished attic or second-floor room. If your room is not exactly like this one, you can easily adapt the plan to your own project by following the directions carefully.

Regardless of the kind and size of the room you are building, you must remember that building materials come in stock sizes. Wherever possible, then, erect framing so that walls, door spaces, window openings, etc., will accommodate these standard sizes. This may save you hours of unnecessary cutting and fitting. Your lumber dealer will help you with this when you talk over your job with him.

1. Make a rough sketch. Make a rough pencil drawing of your room similar to Fig. 34-9. You don't need to indicate furniture or other furnishings. However, show the location of all existing and proposed partitions, closets, windows and doors. Indicate the dimensions of the area you are going to finish off. Measure the length and width along the floor and the various ceiling heights. By this, we mean the highest point of the ceiling and the lowest point, or where the roof slants down to meet the kneewalls. If your attic is completely unfinished, it will look like the area within the heaviest black line, as shown in Fig. 34-10. If it has kneewalls, it may look like the shaded area or extended out as shown by the dotted line. Remember the standard lengths and widths. This is the first place to apply them. If you require kneewalls, try to make them four feet high because standard wallboard comes 4′ x 8′ in size. One more thing: if the room you are going to build is part of a bigger area, get the floor measurement of the whole attic. From this you can figure the size of the ventilation space needed for proper air circulation.

Be sure to note whether the area is floored, unfloored or partly floored. Also indicate whether it is insulated between the floor joists or the rafters. Indicate if there is no insulation.

2. See your lumber dealer. Take your rough sketch and measurements down to your local lumber and building material dealer. Discuss your whole project with him. He'll be glad to help you in any way he can and will show you the easiest, least expensive and best way to make this room come to life. Perhaps he can show you where you can make other improvements or additions within your budget.

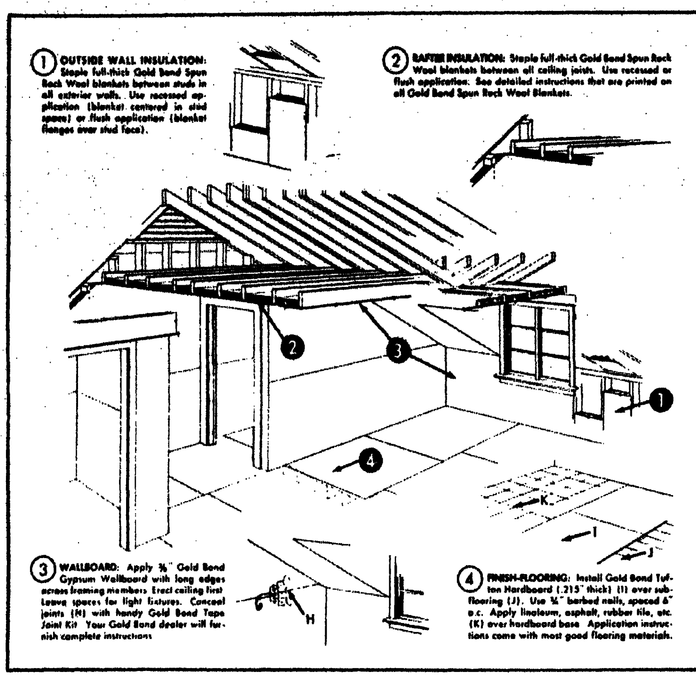
Your dealer will measure out all the things you need. He will show you how to do anything you are not already able to do. He will deliver everything to your door when you want it. The chances are you will want to do this project in stages. Be sure to tell your dealer and he will deliver the materials as you need them.

Now you are ready to start the actual work on your room.

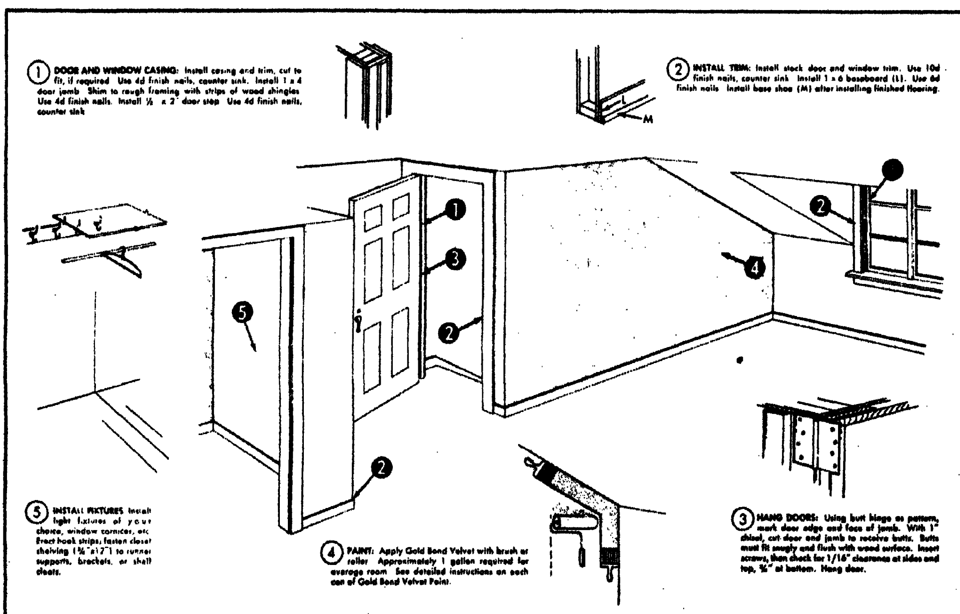
3. Install subflooring. Fig. 34-11.

4. Add ventilation. Fig. 34-12.

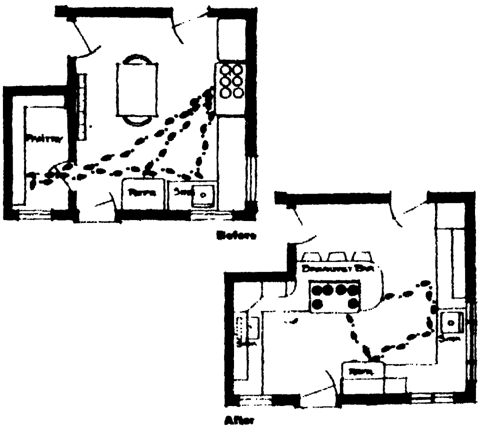
5. Erect framing. Mark out room



34-12. Framing and ventilation.



34-13. Finishing, trim and painting.



34-14. Here is a typical remodeling job for a kitchen. Notice how inefficient the original plan is.

area on floor and install the framing. Be sure that all studs are perpendicular (plumb) throughout. Fig. 34-12.

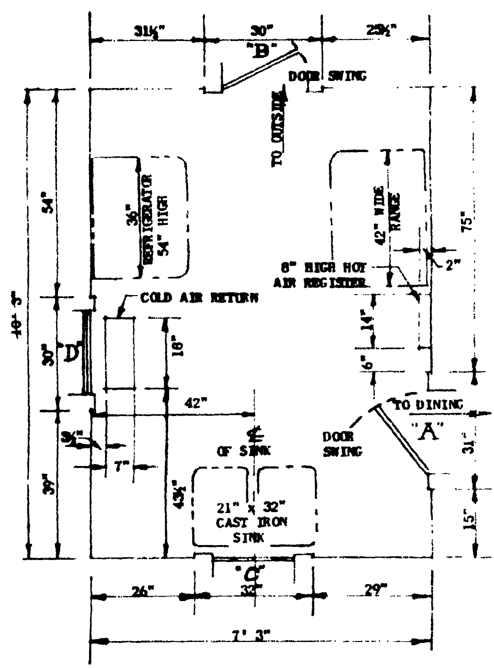
6. Add wiring.
7. Add insulation.
8. Erect wallboard. Fig. 34-13.
9. Finish the flooring.
10. Make the door and window openings.
11. Install trim.
12. Hang the doors.
13. Paint.
14. Install the fixtures.

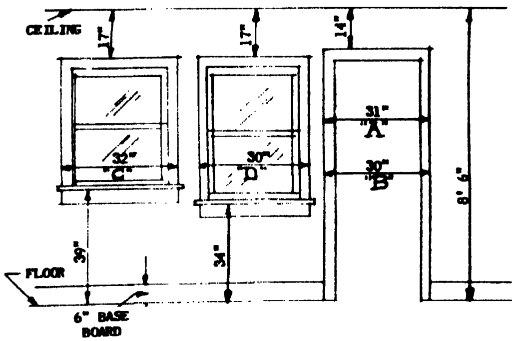
REMODELING A ROOM OF YOUR HOME

In many older homes such areas as the kitchen and bathroom are out-of-date. This provides a good chance for you to plan a remodeling job. Fig. 34-14. The first step in remodeling is to make a rough floor plan and an elevation view of the area. Here are the steps that you can follow in making a floor plan of the kitchen, showing the doors, windows, and other stationary objects.

1. Measure from wall to wall at countertop height (36″ from the floor, more or less, according to the height of the person who will use it the most).
2. Start in each corner and measure to the edge of the window or door casings (if any). Then measure over the casing and to the corner. NOTE: These measurements must equal the overall dimensions of the wall. Fig. 34-15.
3. Locate any stationary objects and give their sizes.
4. Make a rough elevation (see Fig. 34-16) of windows and doors.

34-15. Drawing of a kitchen floor plan.



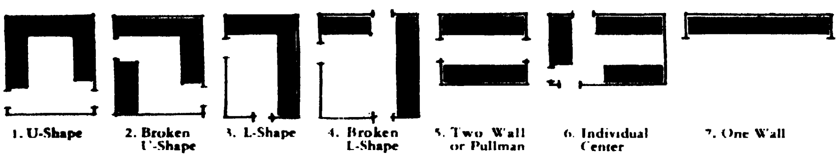


34-16. An elevation drawing of kitchen floor plan.

to help in planning a cabin or home. Or you may have the job of helping to build one. The most common styles are traditional and modern. Fig. 34-19.

Here are some things you should know:

1. Parts of a home. The details of construction are better understood if you know the major parts of a house. Fig. 34-20 to Fig. 34-23 show a house in four stages of construction.



34-17. Common shapes of kitchens.

Give measurements above and below each opening.

5. Show the measurement of floor to ceiling.

6. Show the height of the baseboard.

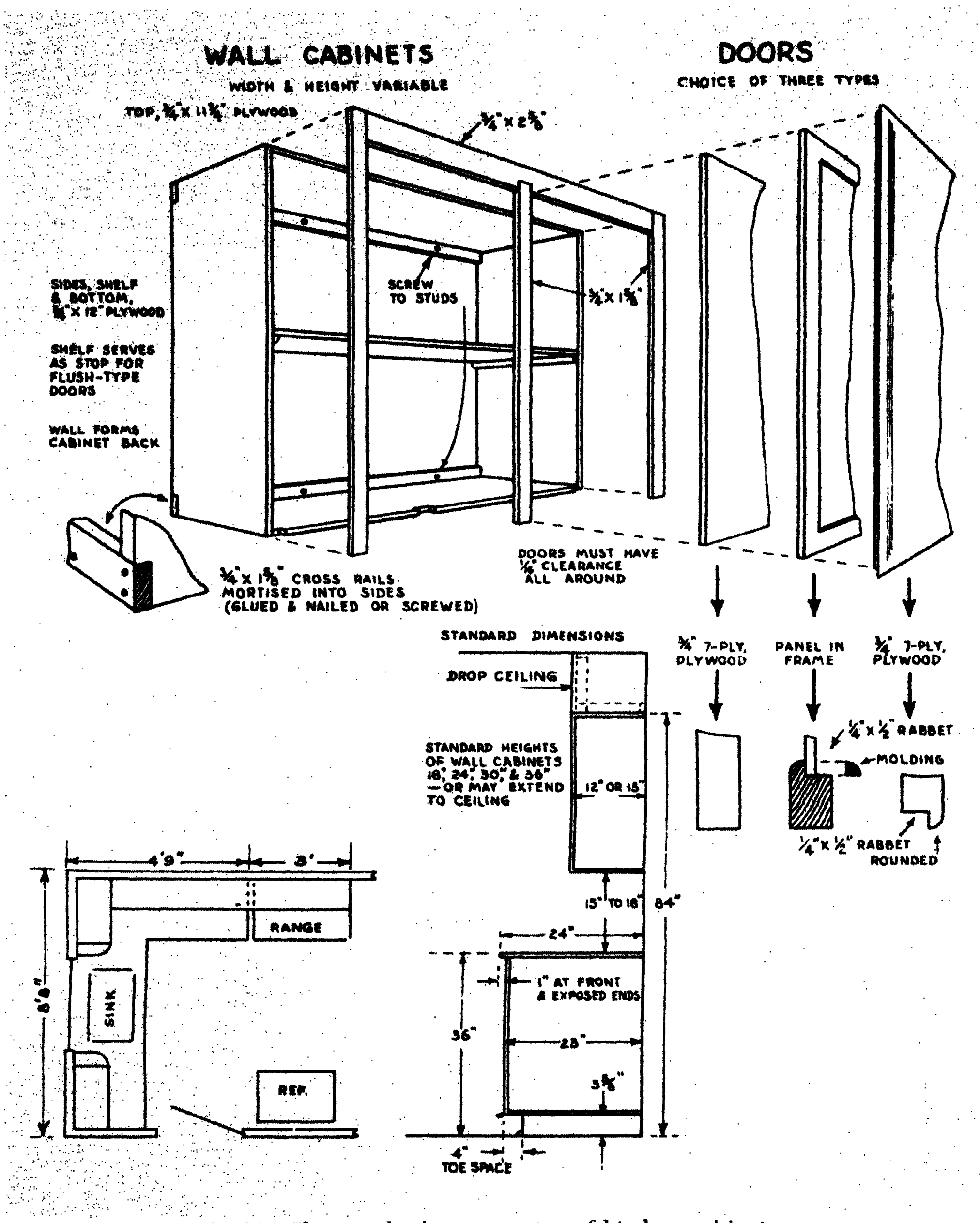
7. Show the preferred location (if any) of appliances and their sizes.

The next step is to decide the kind of kitchen arrangement your family wants. The two most common arrangements for kitchens are the U-shape and the L-shape. Fig. 34-17. With the rough floor plan and other information you can take the plans to any builder. Fig. 34-18. He will help you to plan a modern kitchen.

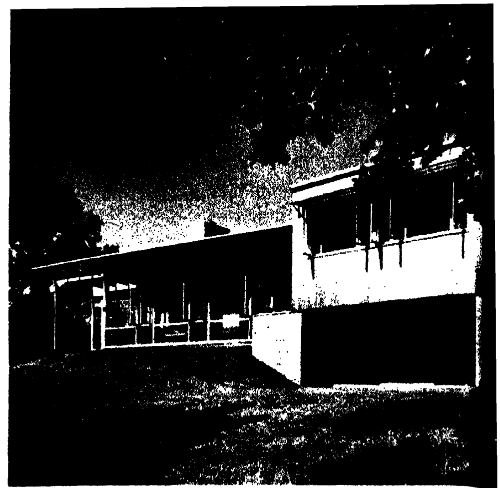
PLANNING A COMPLETE CABIN OR HOME

Some day you may have a chance

2. Planning a home. You should not expect to make complete plans for a home or cabin. Fig. 34-24. You can make preliminary sketches or drawings, however. Fig. 34-25. These sketches can be done in the same way you would proceed to make an addition. Draw the overall size and shape of the house to scale (usually ¼" = 1'). Divide the house into the desired number and size of rooms. There are at least two ways of securing a complete set of plans for a home. The first is to look through books on house and cabin plans until you find one that is very much like the one you have in mind. You can buy these complete plans from many companies. Fig. 34-26. The second method is to take the preliminary sketches to an architect



34-18. The standard construction of kitchen cabinets.



34-19. A good example of traditional and modern homes.

who will make a complete set of plans for you.

3. Estimating the cost of a cabin or house. In the early stages of planning you will want some idea of how much the building will cost. A way to find out is to ask a building contractor about the approximate cost to build a house per square foot. Then figure the number of square feet in your floor plan by multiplying the width by the length. Fig. 34-27. This number multiplied by the cost per square foot will give you a rough estimate of the building cost. Another method is to figure the cubic feet in the house (width times length times height).

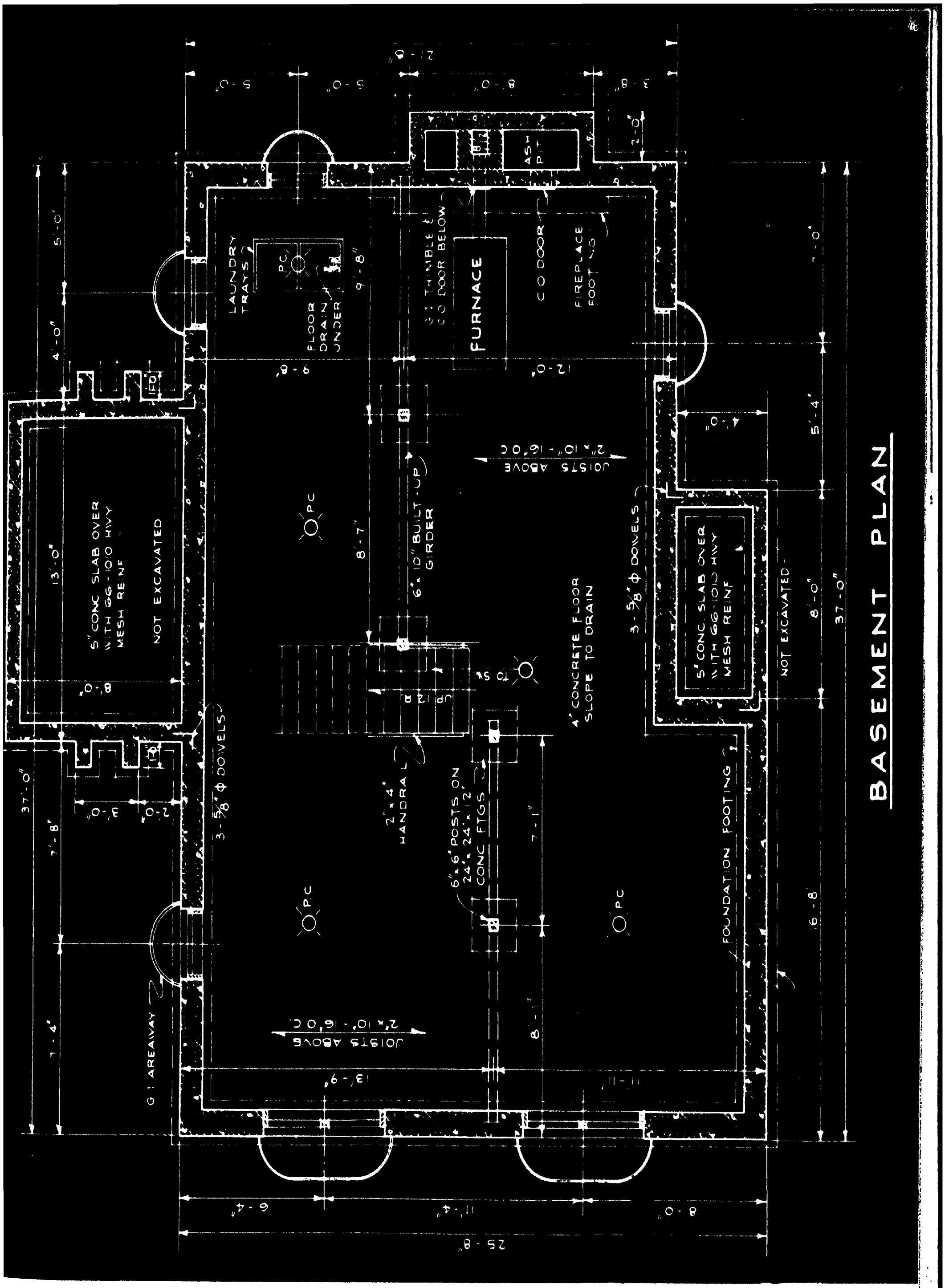
The building cost will vary, of course. It depends on many things such as the type of house, the kind of construction, and the kind of heating. In general the cost of the house itself should equal about 80 to 85 per cent of the total cost, and the lot and landscaping should equal about 15 to 20 per cent. A rule some people follow is this: the total cost of a house and lot should not exceed two and one half times the annual income of the owner.

4. Symbols for house plans. Before you can read house plans you must know the common architectural symbols. Symbols are very simplified drawings of the things they represent. Fig. 34-28 shows the common symbols for doors and windows, materials and plumbing. In Section IV, Unit 30, the symbols for electrical wiring are given.

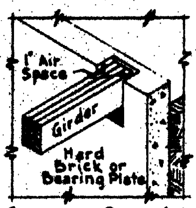
5. Reading house plans. A complete set of house plans may include five different kinds of drawings. These are:

a. Floor plan. This shows a view of the floor as you would look down on it from the top. A two-story house with basement would have three floor plans. These plans give details of the size and shape of each room, the location of heating, plumbing and electrical installations and other information. Fig. 34-29.

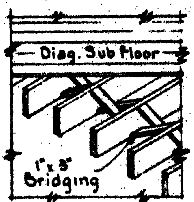
b. Elevations. Elevation views



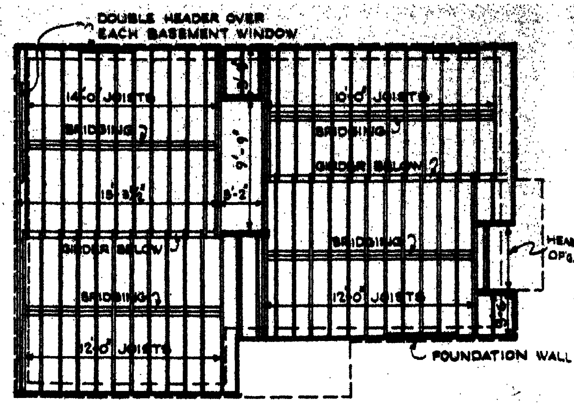
34-20. The first stage in construction of a home: basement completed. Floor plan for this home is shown in Fig. 34-25.



GIRDER BOX IN FOUNDATION WALL

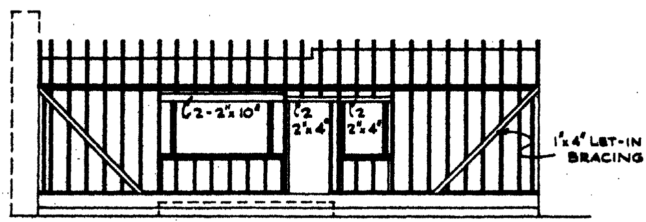


JOIST BRIDGING

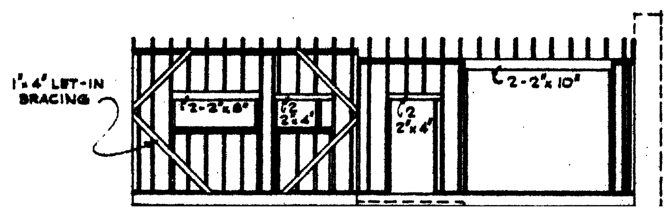


FLOOR

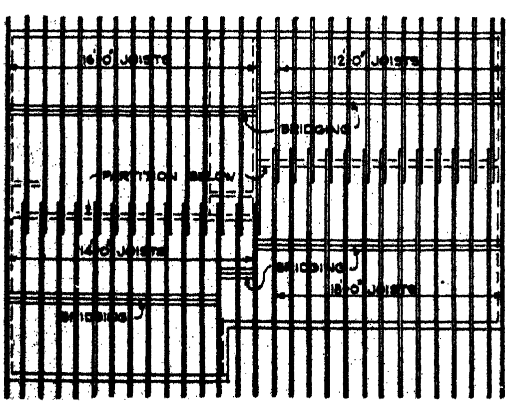
34-21. Second stage in construction of a home: floor joists and sub-floor completed. All floor and ceiling joists to be 2" x 10", 16" on center.



REAR



FRONT



ROOF

34-22. Third stage in construction of a home: framing completed. Framing for right and left side not shown.

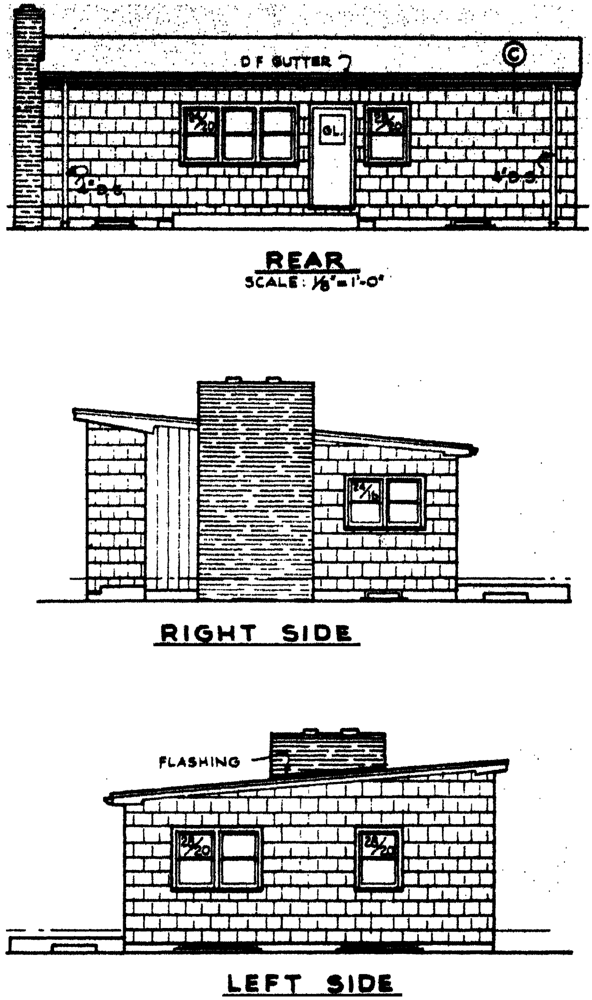
show how the house would look from several views. They are much like the views of a working draw-

ing. Often there will be four elevations: front, right side, rear, and left side. Thus you can see exactly how the house will look on these four sides. These elevations contain a good deal of information about the size and shape of windows and doors, the kind of exterior and roof, and other important details. Fig. 34-30.

c. Detail elevations. Detail elevations are view drawings showing certain parts of the house in very great detail. For example, the the drawings may include a detail elevation of the kitchen cabinets or a living room wall showing the builder exactly how the parts are to be built and assembled. Fig. 34-31.

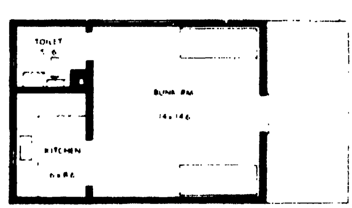
d. Sections. Sections are cross-section views of various parts of the house. Sometimes there will be a cross-section view showing the exterior wall of the house. This describes in detail exactly what goes into the construction. There may also be section drawings of the detail elevations showing the builder how to construct them. Fig. 34-32.

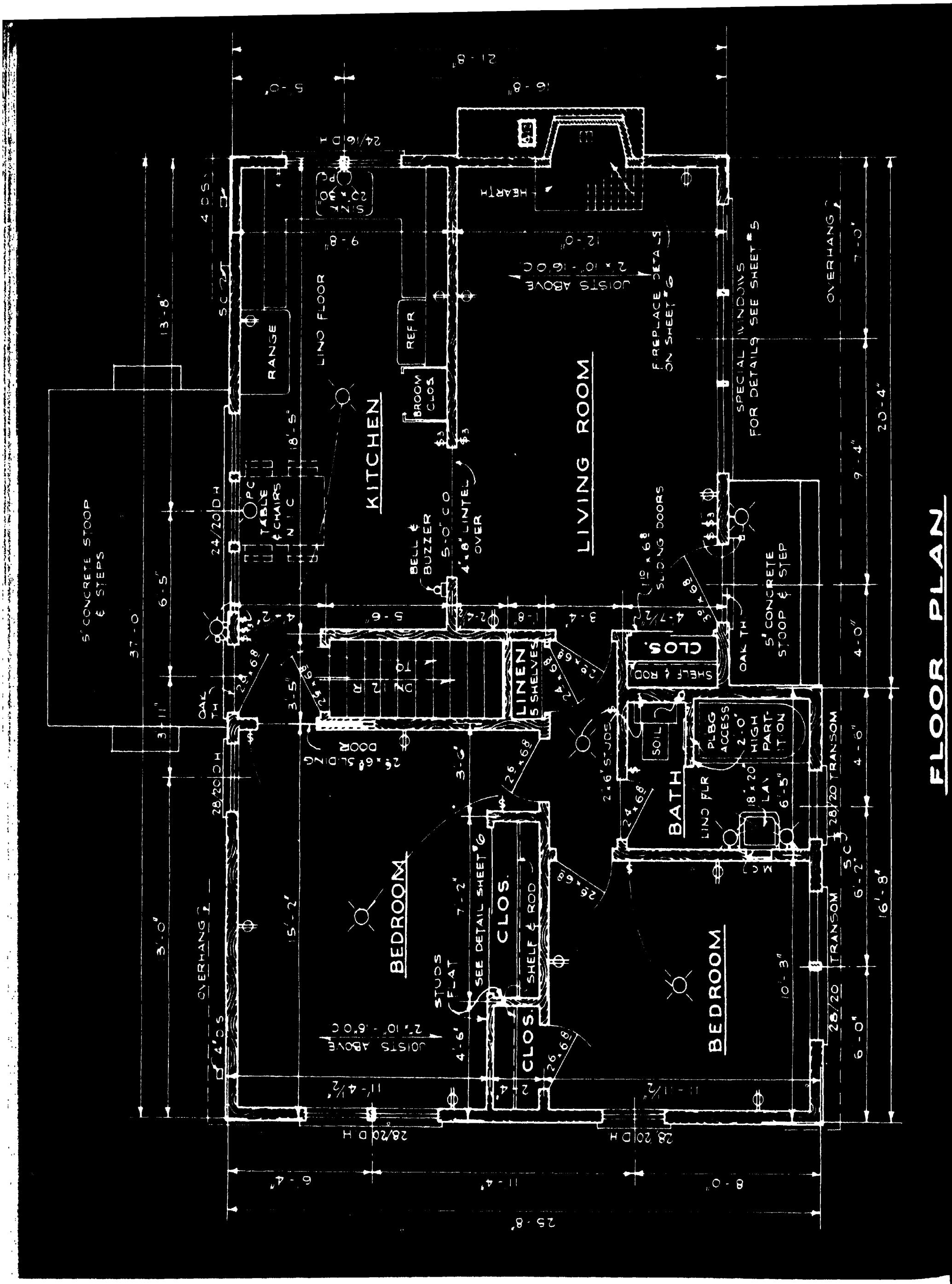
e. Presentation drawings or pictorial renderings. These are perspective drawings of the house or building showing how it will look when it is all finished. This drawing is usually done in pencil, ink, and/or watercolor. The drawing is very complete and includes trees, walks, shrubs, and other details. These drawings are made so lifelike that they look much like a



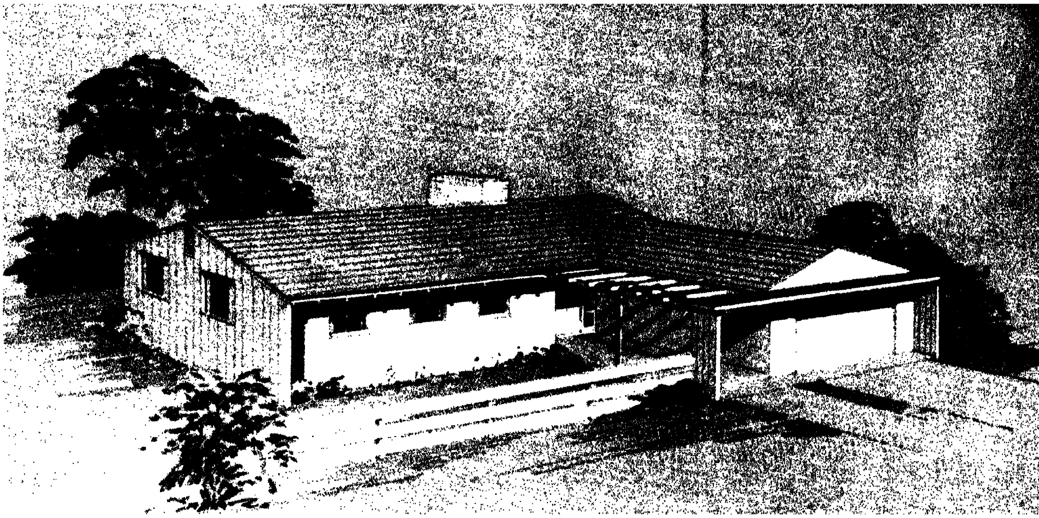
34-23. Fourth stage in construction of a home: exterior completed. Front elevation is shown in Fig. 34-30.

34-24. A floor plan of a simple cabin.

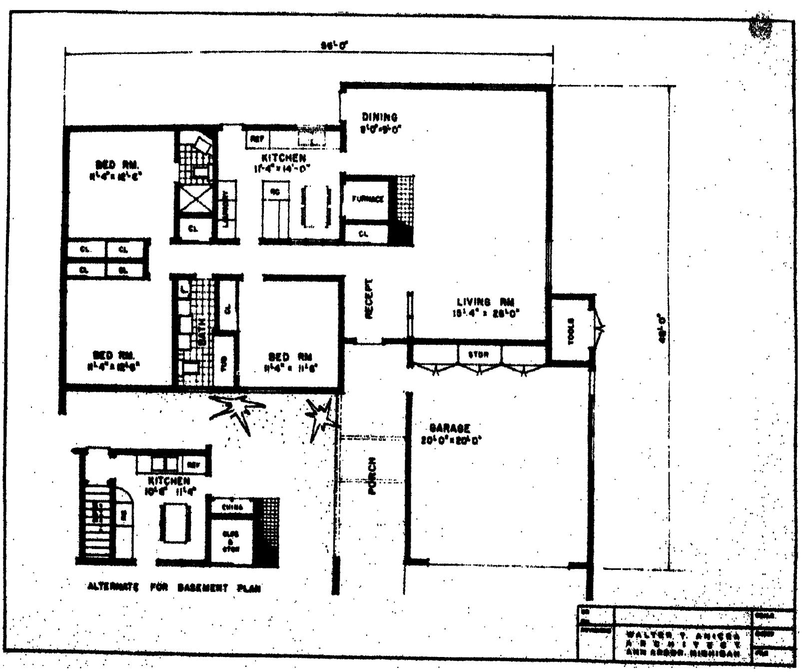


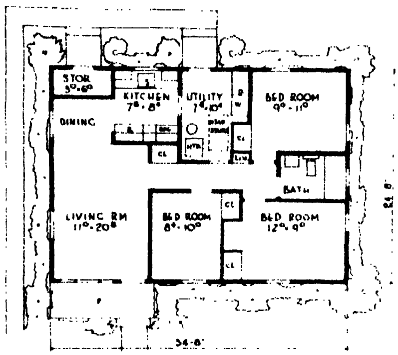


34-25. This shows some of the standards for drawing a plan view of a home.



34-26. Complete plans for a home like this can be secured from many companies.





34-27. How many square feet of space are there in this floor plan?

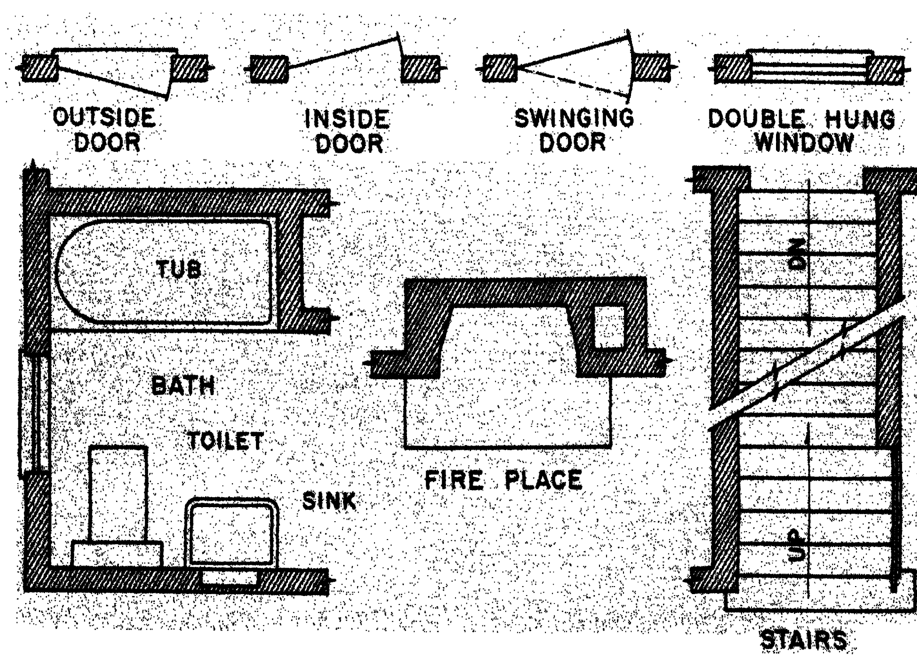
photograph of the finished building. In addition, some people have an actual scale model built. This is the best way to see what the finished building will really look like. Fig. 34-26.

BUILT-INS

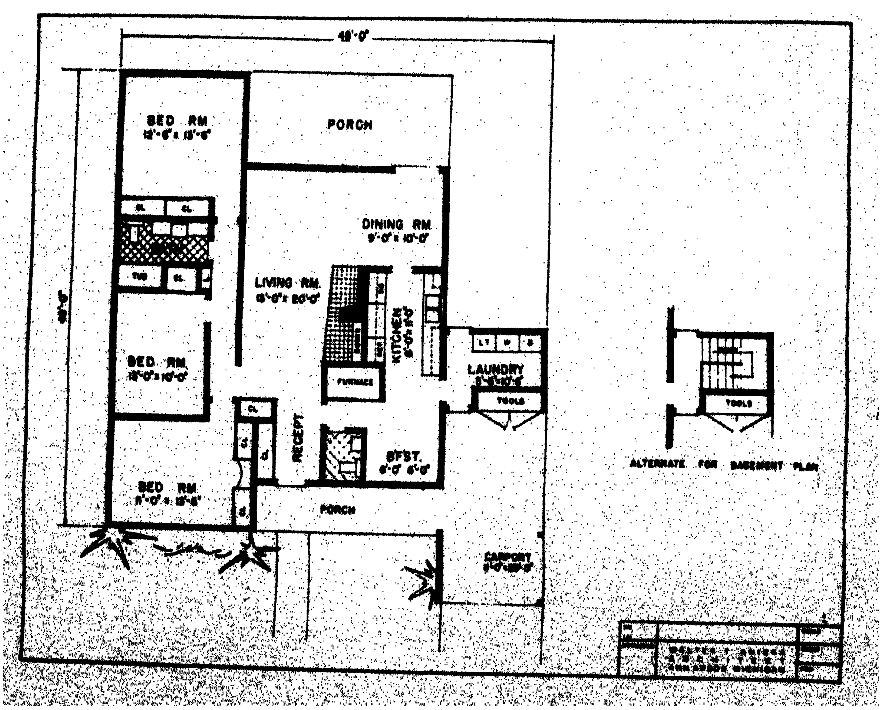
In the remodeling of an old home or the building of a new one, important features are the built-ins. Today, built-ins are found in almost every home to satisfy the need for lots of storage space of all types. Built-ins include book shelves, drawers and cabinets. Fig. 34-33. These are found inside the home as well as in the garage and outside the home.

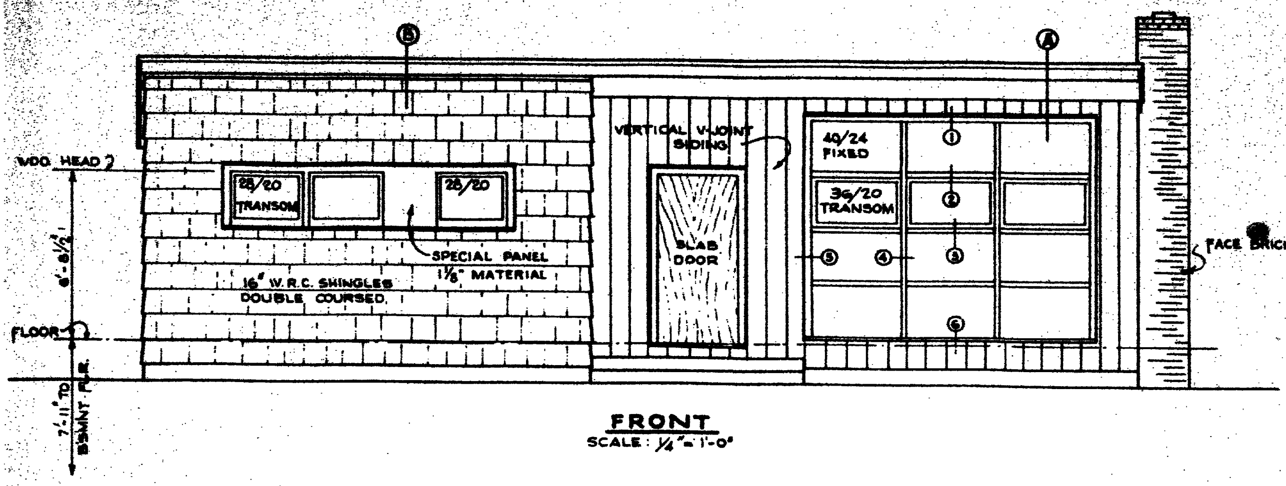
Most drawings for built-ins are a combination of several kinds. They may be two-view working drawings or isometric or perspective drawings. Fig. 34-34.

34-28. Symbols used in house plans.



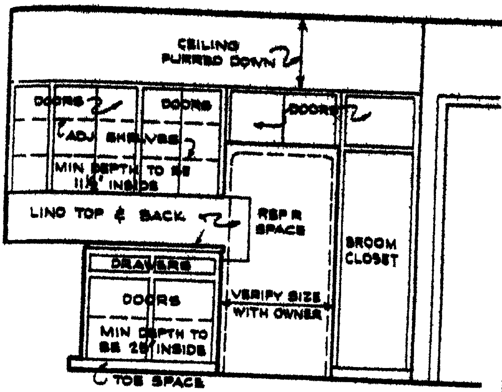
34-29. Floor plan and artist's rendering.



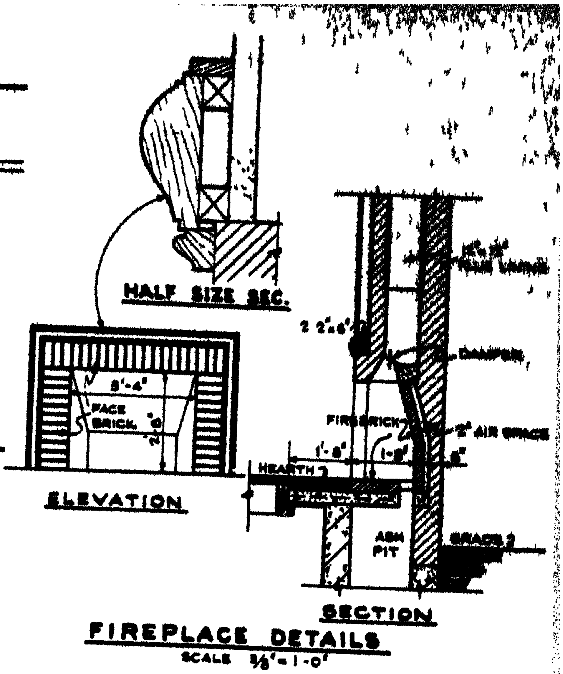


ELEVATIONS

34-30. An elevation view.

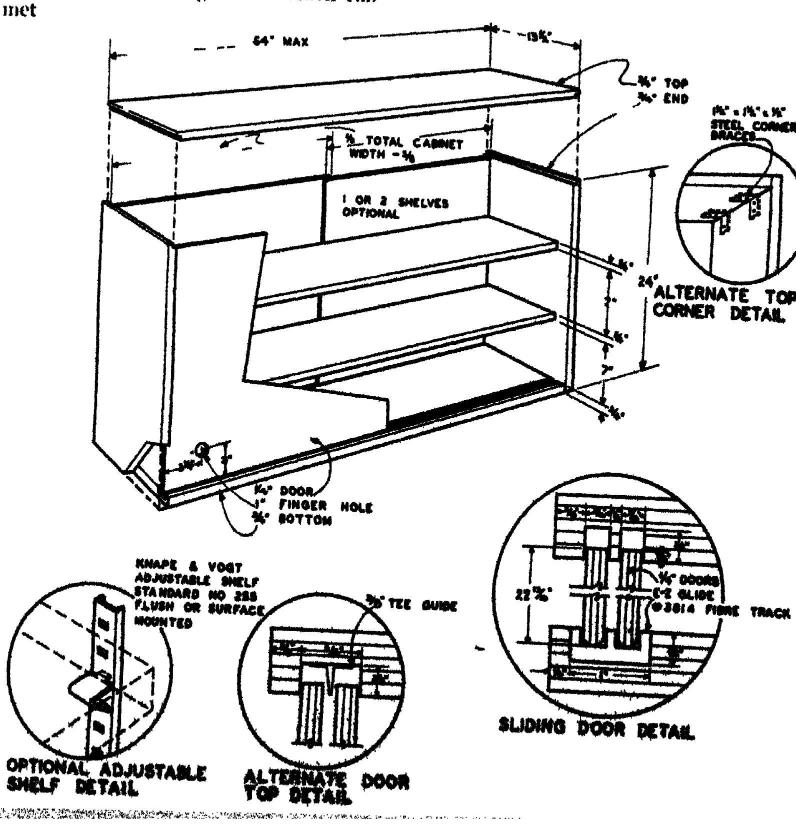


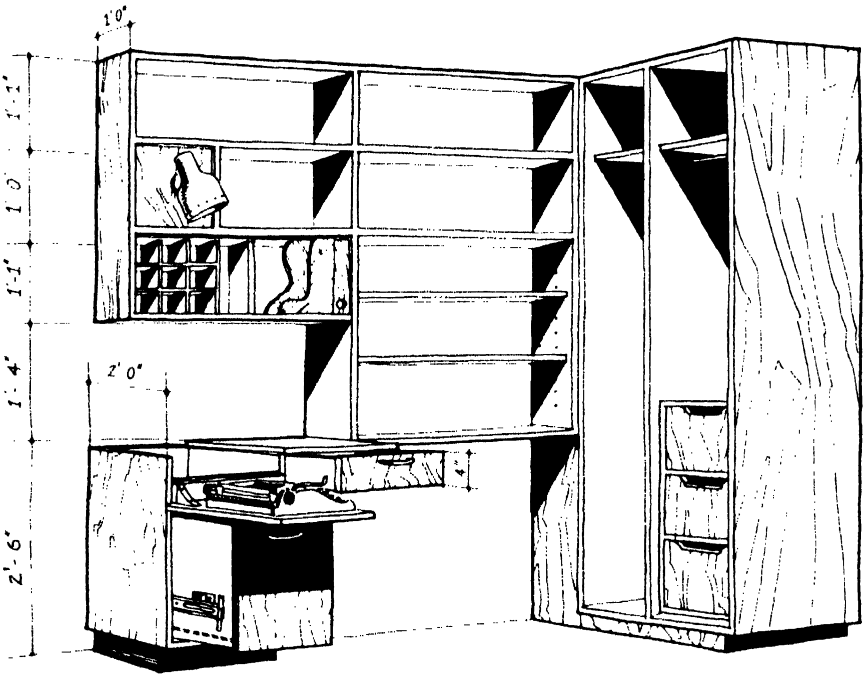
34-31 A detail elevation for kitchen cabinet for the house shown in Fig 34-25.



34-32. A section of the fireplace for house shown in Fig. 34-25

34 33 Pictorial drawing for a kitchen cabinet





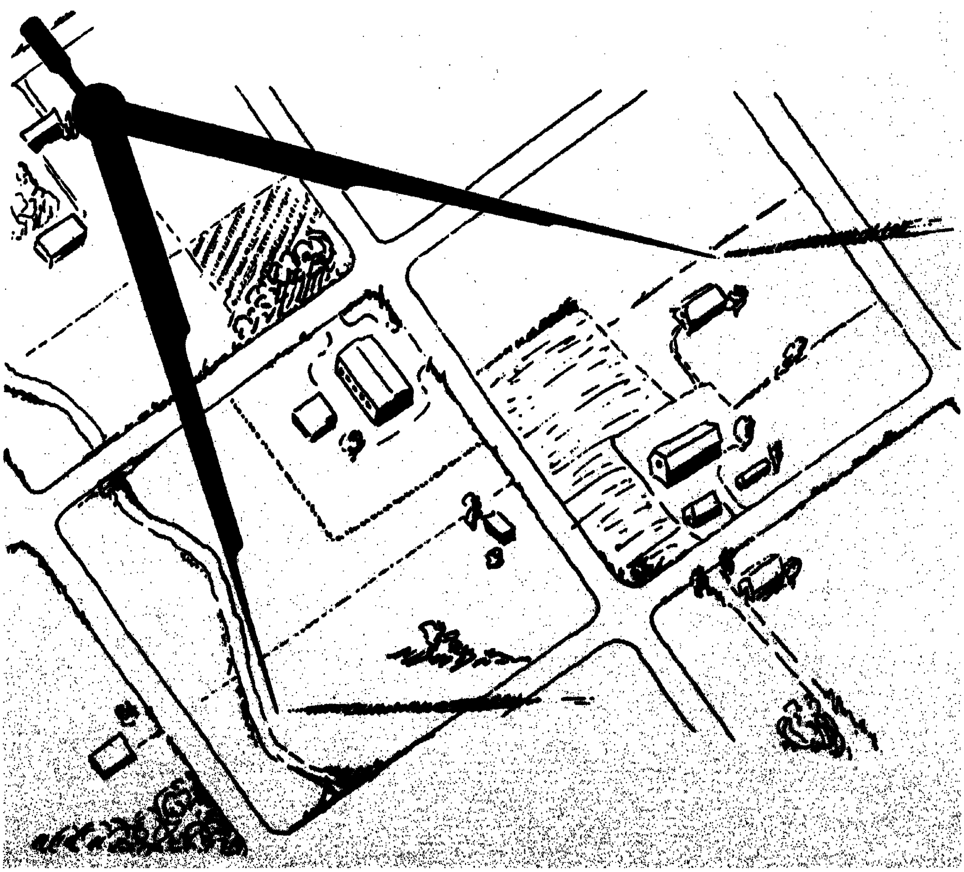
34-34. Simplified sketch for a built-in desk and shelves. *Note that dots have been used instead of arrowheads.*

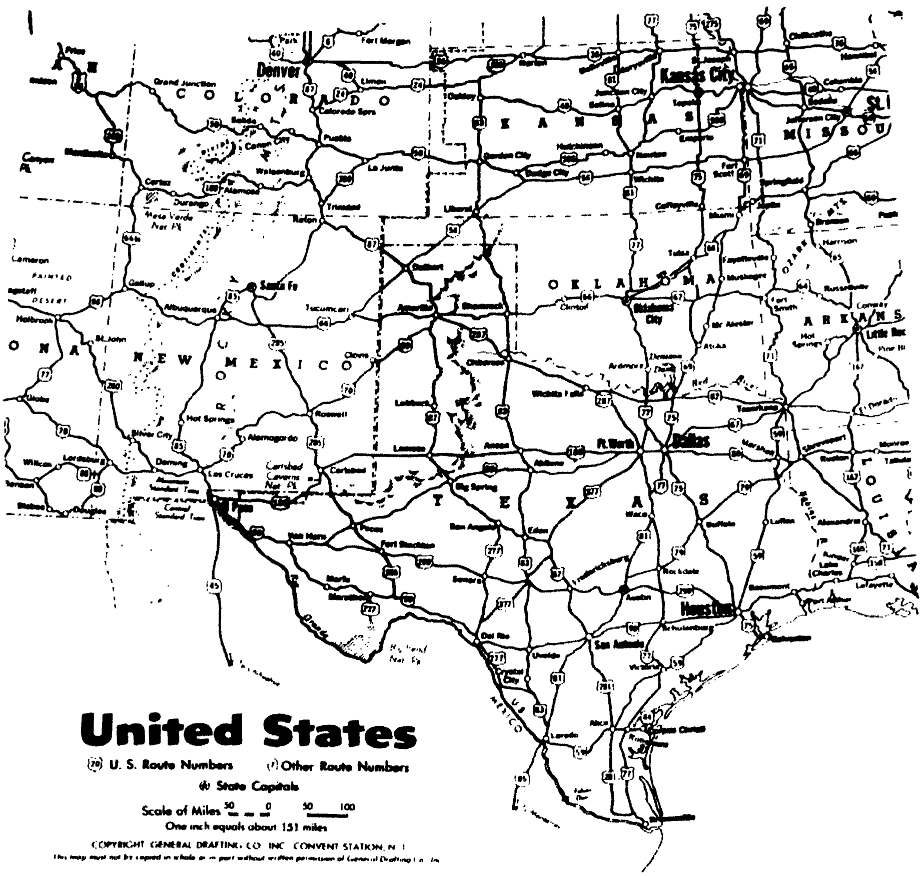
35. Map Drawings

A map is a one-view drawing of some part of the world's surface. It looks like a view you might see from an airplane. Fig. 35-1. Have you ever taken an imaginary trip by looking at a map? There's magic in maps. They tell you a great deal about the world in which you live.

Maps are of various kinds. A map may be made of the same part of the world for many different purposes. A *highway map* of your state will show

35-1. You might draw a map of a small area in which you live in this way.

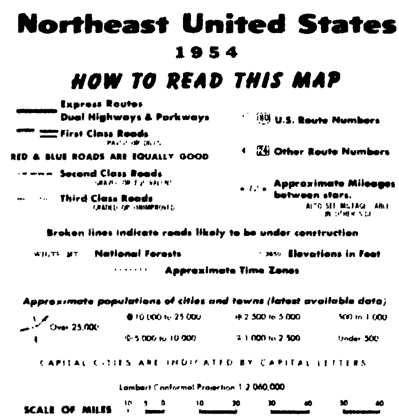




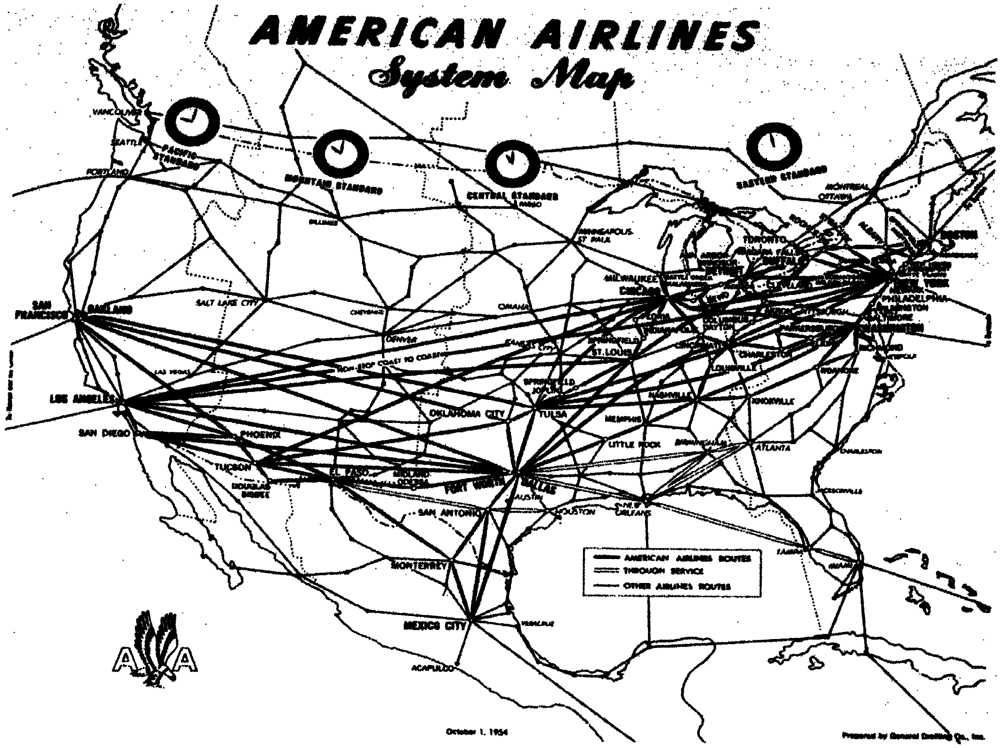
35-2. A road map.

roads and cities, while a *conservation map* might show the lakes, forests, streams, and fishing and hunting sites. Here are some of the common kinds of maps:

Highway or Road Maps. A highway or road map shows the main highways, the distance between cities and towns and, very often, points of interest to the tourist. Fig. 35-2. A guide on each map explains the symbols and how to read them. Fig. 35-3. Some highway maps are so complete

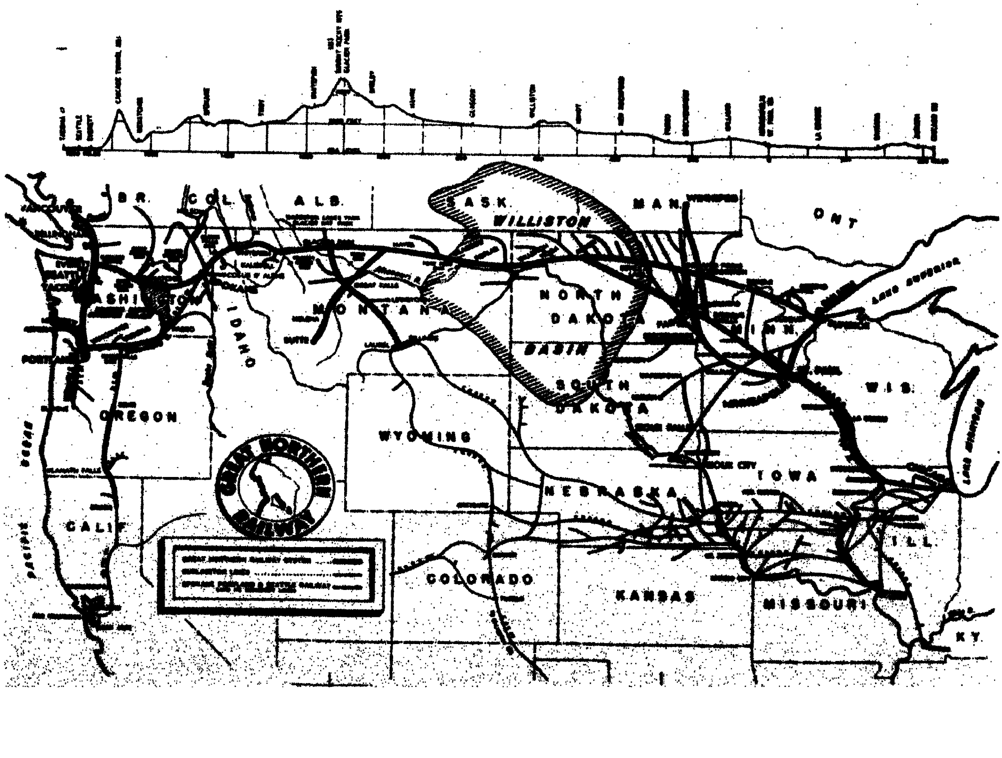


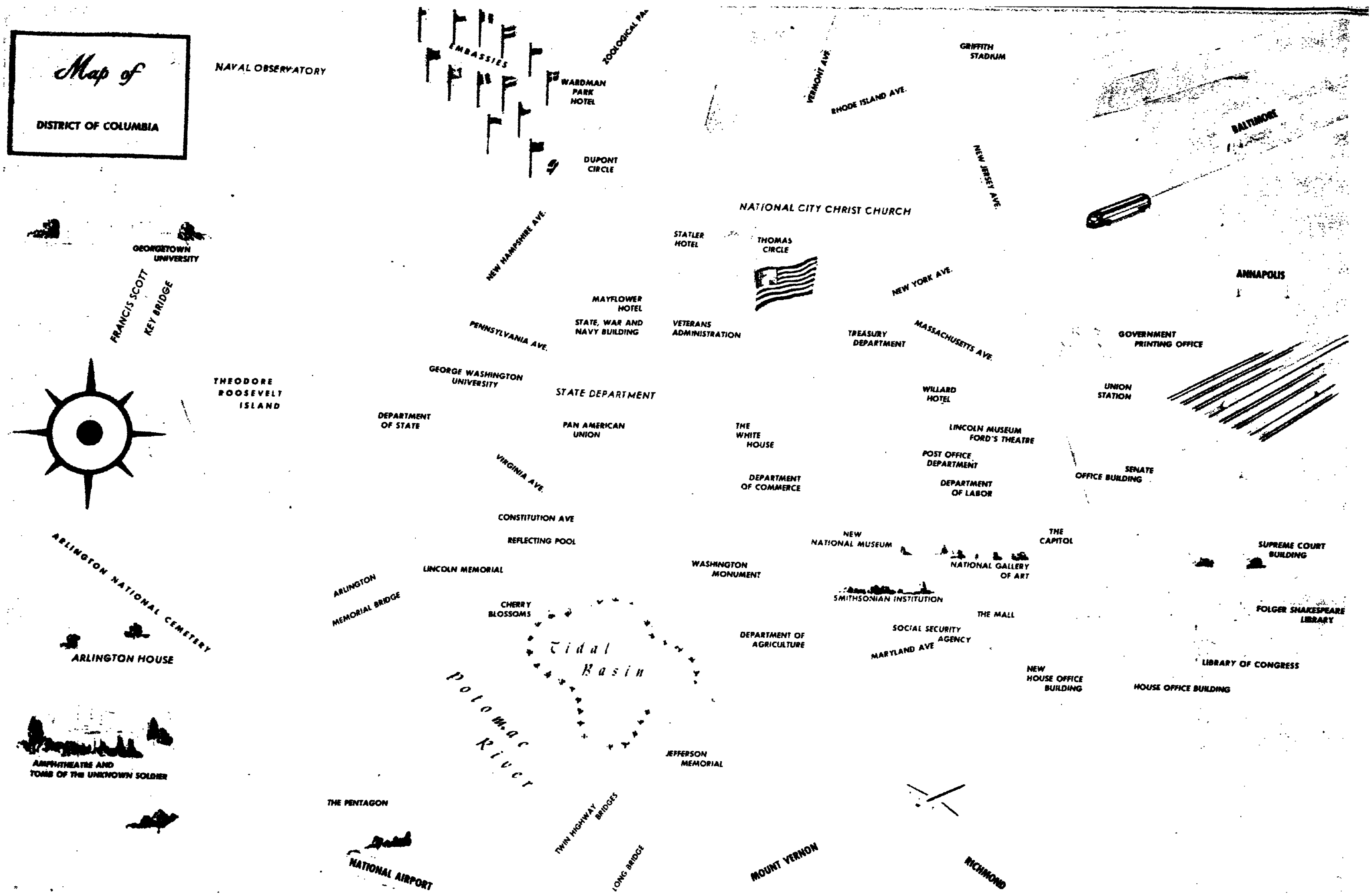
35-3. This guide will help you read a road map.



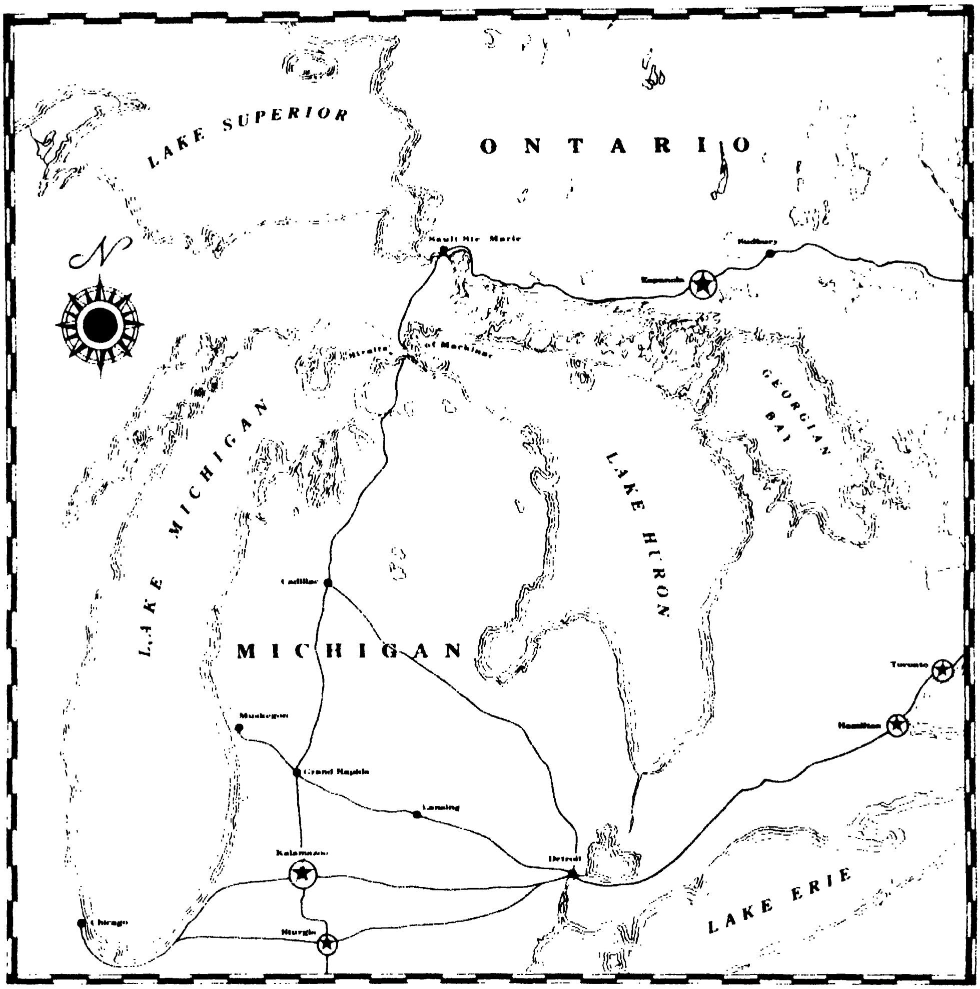
35-4. An airline map of the United States.

35-5. A railroad map of the northwest section of the United States.





Map of
DISTRICT OF COLUMBIA
NAVAL OBSERVATORY
EMBASSIES
ZOOLOGICAL PA
WARDMAN PARK HOTEL
DUPONT CIRCLE
VERMONT AVE.
RHODE ISLAND AVE.
GRIFFITH STADIUM
BALTIMORE
NEW JERSEY AVE.
NATIONAL CITY CHRIST CHURCH
GEORGETOWN UNIVERSITY
FRANCIS SCOTT KEY BRIDGE
NEW HAMPSHIRE AVE.
STATLER HOTEL
THOMAS CIRCLE
NEW YORK AVE.
ANNAPOLIS
MAYFLOWER HOTEL
STATE, WAR AND NAVY BUILDING
VETERANS ADMINISTRATION
TREASURY DEPARTMENT
MASSACHUSETTS AVE.
GOVERNMENT PRINTING OFFICE
PENNSYLVANIA AVE.
GEORGE WASHINGTON UNIVERSITY
STATE DEPARTMENT
THEODORE ROOSEVELT ISLAND
WILLARD HOTEL
UNION STATION
DEPARTMENT OF STATE
PAN AMERICAN UNION
THE WHITE HOUSE
LINCOLN MUSEUM FORD'S THEATRE
POST OFFICE DEPARTMENT
SENATE OFFICE BUILDING
VIRGINIA AVE.
DEPARTMENT OF COMMERCE
DEPARTMENT OF LABOR
CONSTITUTION AVE
REFLECTING POOL
NEW NATIONAL MUSEUM
THE CAPITOL
ARLINGTON NATIONAL CEMETERY
LINCOLN MEMORIAL
WASHINGTON MONUMENT
NATIONAL GALLERY OF ART
SUPREME COURT BUILDING
ARLINGTON MEMORIAL BRIDGE
SMITHSONIAN INSTITUTION
CHERRY BLOSSOMS
THE MALL
FOLGER SHAKESPEARE LIBRARY
DEPARTMENT OF AGRICULTURE
SOCIAL SECURITY AGENCY
MARYLAND AVE
ARLINGTON HOUSE
Tidal Basin
NEW HOUSE OFFICE BUILDING
LIBRARY OF CONGRESS
HOUSE OFFICE BUILDING
Potomac River
AMPHITHEATRE AND TOMB OF THE UNKNOWN SOLDIER
JEFFERSON MEMORIAL
THE PENTAGON
TWIN HIGHWAY BRIDGES
LONG BRIDGE
MOUNT VERNON
RICHMOND
NATIONAL AIRPORT



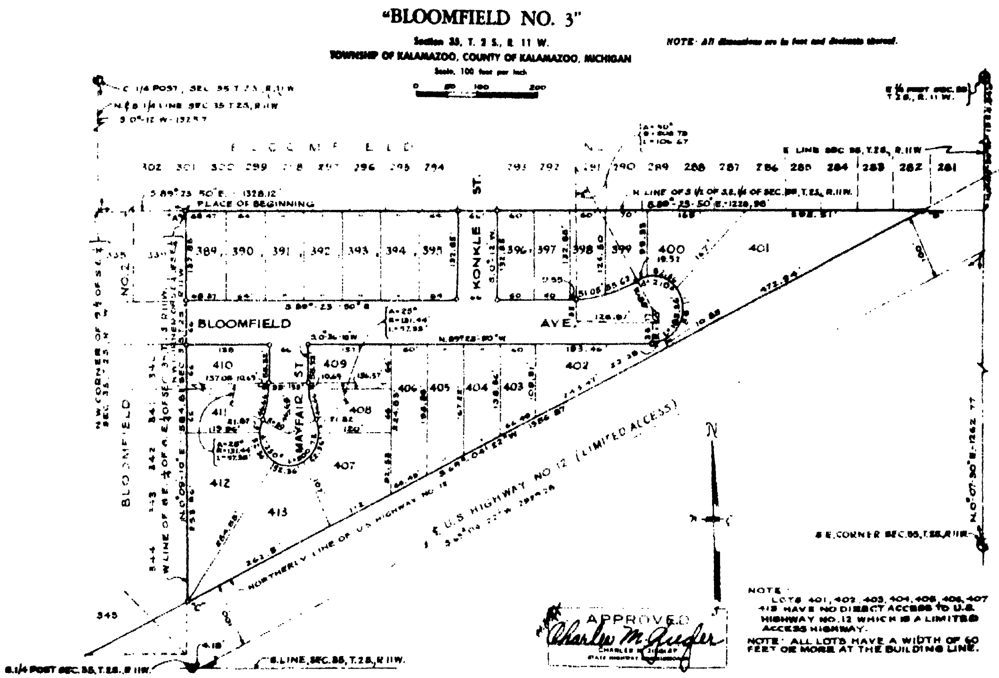
35-7. A map used by a company to show plant locations.

they show state parks, museums, forests, airports, and many other things.

Maps always have a graphic scale to show the size of the map. You can use this scale to find the distance between cities and towns. It will also help you to estimate the distances you have traveled on a trip. Most maps show the distance between cities, with the number of miles lettered along the lines representing the highways and roads.

Airline Maps. An airline map shows the location of all the major cities served by aircraft. Fig. 35-4. The lines between the cities are drawn "as the crow flies," since airline maps show airline distances.

35-6. A scenic or picture map of Washington, D. C. on facing page.

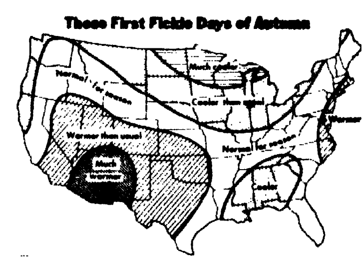


35-8. Section of a plat map of a new development.

Railroad Maps. The railroads usually follow natural terrain (such as rivers and valleys) between the cities they serve. Therefore the lines are not straight. Here, for example, is a map of a railroad that serves the northwest area of our country. Fig. 35-5. Notice the elevation at the various points along its route. Usually railroad maps make a route look straighter than it actually is.

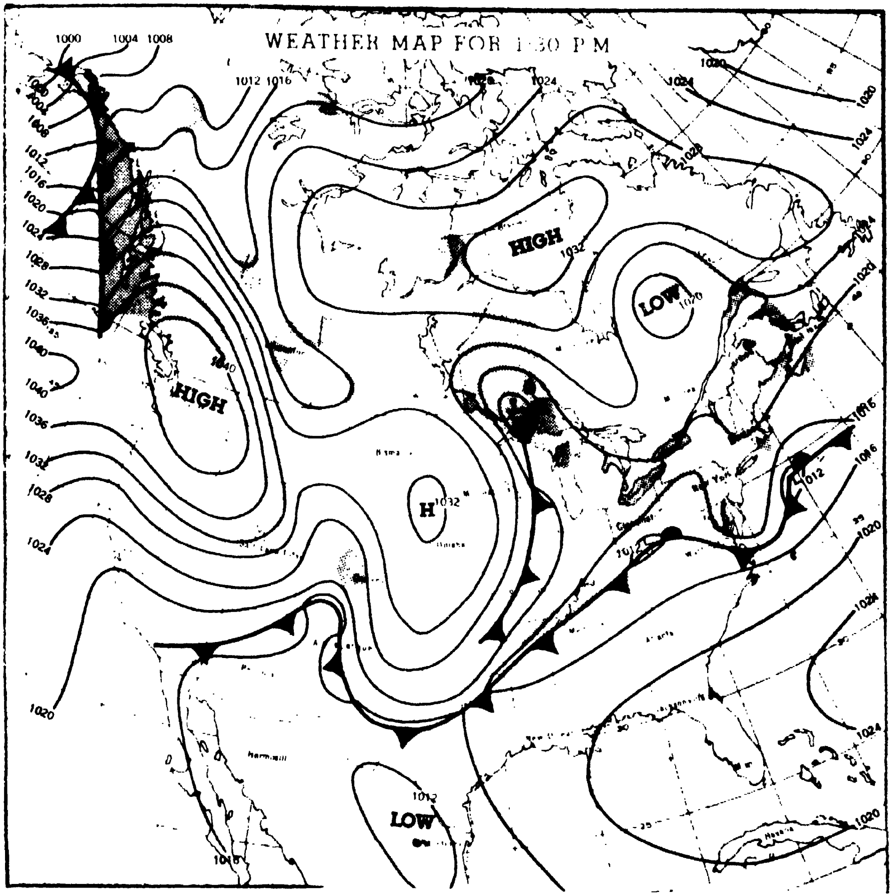
Scenic, or Picture, Maps. Scenic, or picture, maps are actually picture drawings of an area. They are made for easy reading. Notice this scenic map of our national capital. Fig. 35-6. See how easy it is to find the major points of interest. This kind of map is very helpful to the tourist.

Maps for Special Purposes. Many large maps include such things as a smaller map to show the location of industrial plants, a map to show our forests, mineral deposits, and waterways, or any other special information. Fig. 35-7.



35-9. A weather map of the United States.

City Maps. City maps are drawn to show the location of streets; utilities such as water mains or sewer lines; sizes of property, and points of interest.

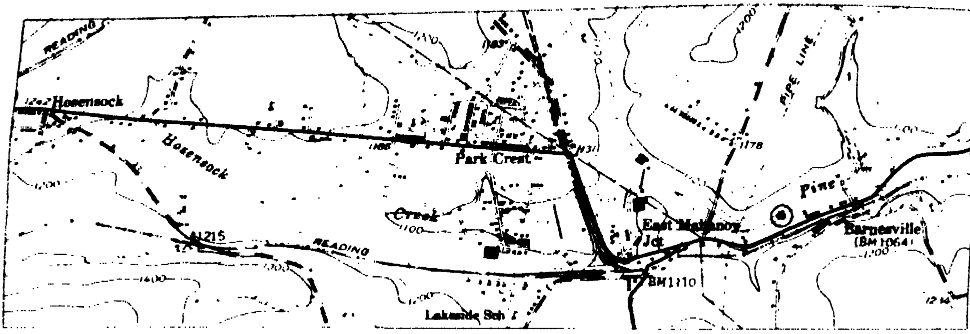


35-10. The weather map shown in Fig. 35-9 is a simplified version of this map.

Plat Maps. When a person purchases a piece of city property, he secures an abstract of title to the land. In that title will be a map of the subdivision. This is called a *plat*. It shows the lot number, the exact size and description of each lot in the plat, the name and width of the streets, and other information of importance. Fig. 35-8.

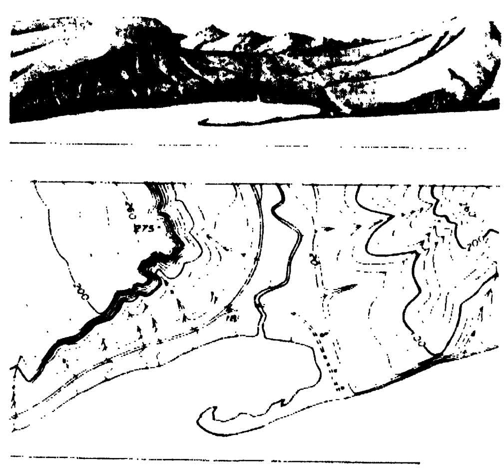
Weather Maps. In your daily paper, on television, and in many magazines are shown or printed weather maps for the next day, week, or season. Fig. 35-9. These maps are simpler forms of maps furnished by the weather bureau of the U. S. Department of Agriculture. Fig. 35-10. Many have symbols that help you to read them correctly.

Topographic Maps. These are the most complete maps of areas that can be drawn. A topographic map shows everything contained in that particular area, including such natural things as lakes, streams, forests, and hills. Man-made developments such as roads, buildings, and bridges are shown also. There are symbols for each of these. Some of the sym-



35-11. A topographic map of a small section of the country. Originally printed in color.

bols are in color so the map may be printed in various colors. Fig. 35-11. Since maps are one-view drawings, they do not show elevations (height). To show hills or valleys, *contour lines* are drawn on the map. The closer together these lines are, the steeper is the slope or depression. These lines are numbered to show the height or elevation in feet in relation to some fixed elevation such as sea or lake level. Fig. 35-12. Maps of this type are made by civil engineers. They survey the land and make careful measurements and field notes. This information is transferred to a finished map drawing. Most of the maps used in everyday life are simpler forms of topographic maps.



35-12. A contour map.

Section V

36. Graphs and Charts

Graphs make facts and figures convenient to read, simpler to compare, and easier to understand. They add interest to any book or magazine by using pictures along with words and figures. There are four common kinds of graphs: the *line and curve*, *bar*, *pictorial* and *circle*, or pie.

LINE AND CURVE GRAPH

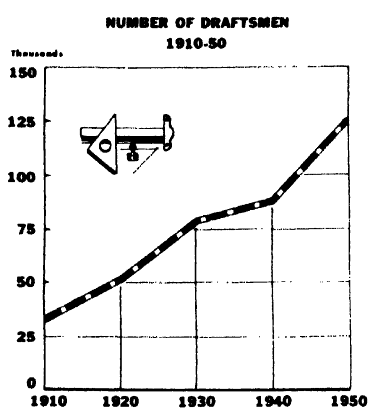
The line and curve graph is used to show what has happened or what might happen. For example, in Figs. 36-1 and 36-2, you see a line graph showing the number of draftsmen, 1910-1950, and the increase in the number of students in college.

Proceed as follows to make a simple line and curve graph:

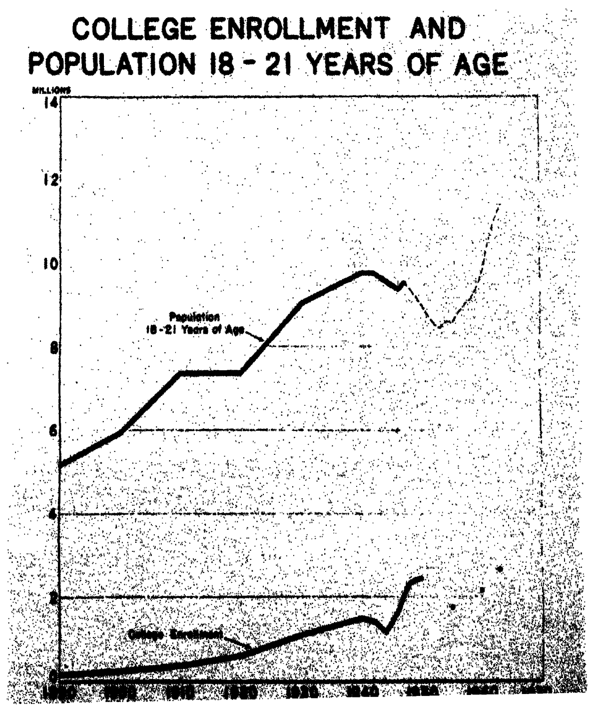
1. Select squared or cross-section paper. If the graph is to be made on plain paper, draw a grid (light lines that form rectangles).

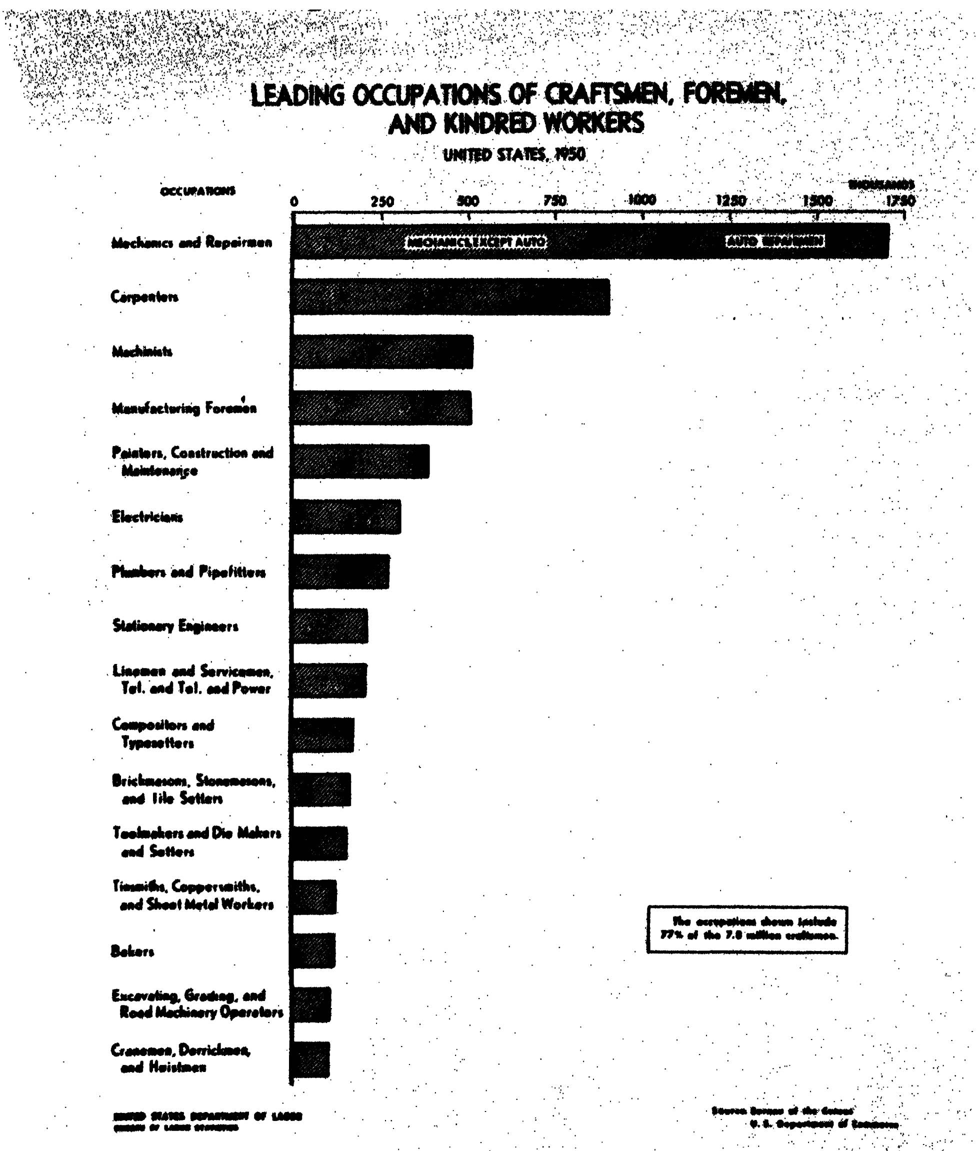
2. Draw a vertical line near the left (or right) edge of the paper.

36-1. A typical line graph used to show growth in the number of draftsmen.



36-2. Another line graph comparing two factors: population growth and college enrollment.

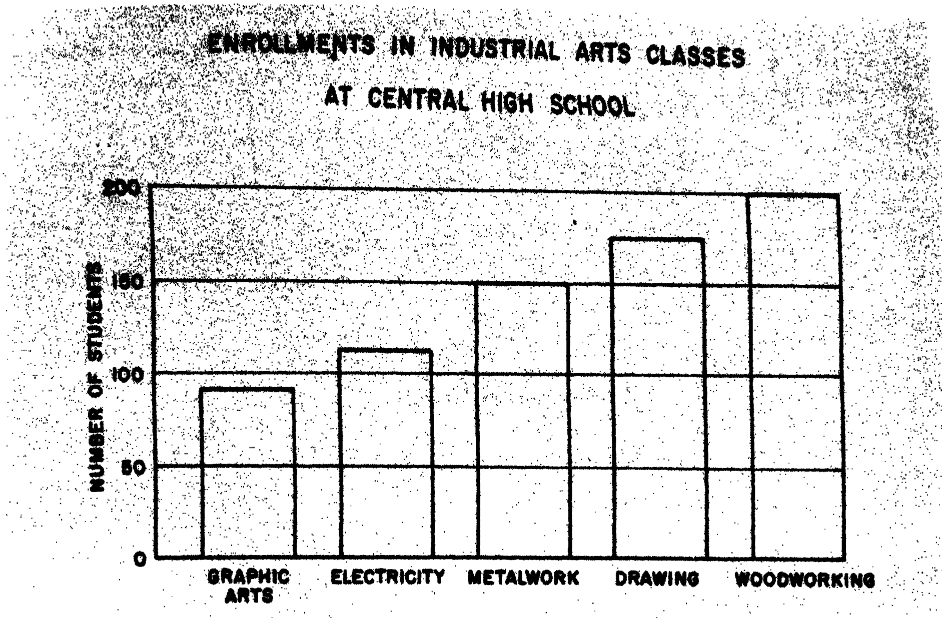




36-3. A bar graph with many horizontal bars.

This line is called the *ordinate,* or Y axis. Draw a horizontal line near the bottom of the page. This is called the *abscissa*, or X axis. Where the two lines join at the zero point is the *origin*.

3. Decide on what information is to be shown. Information that is

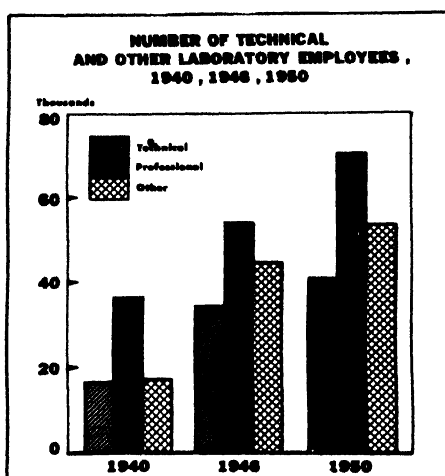


36-4. A vertical bar graph.

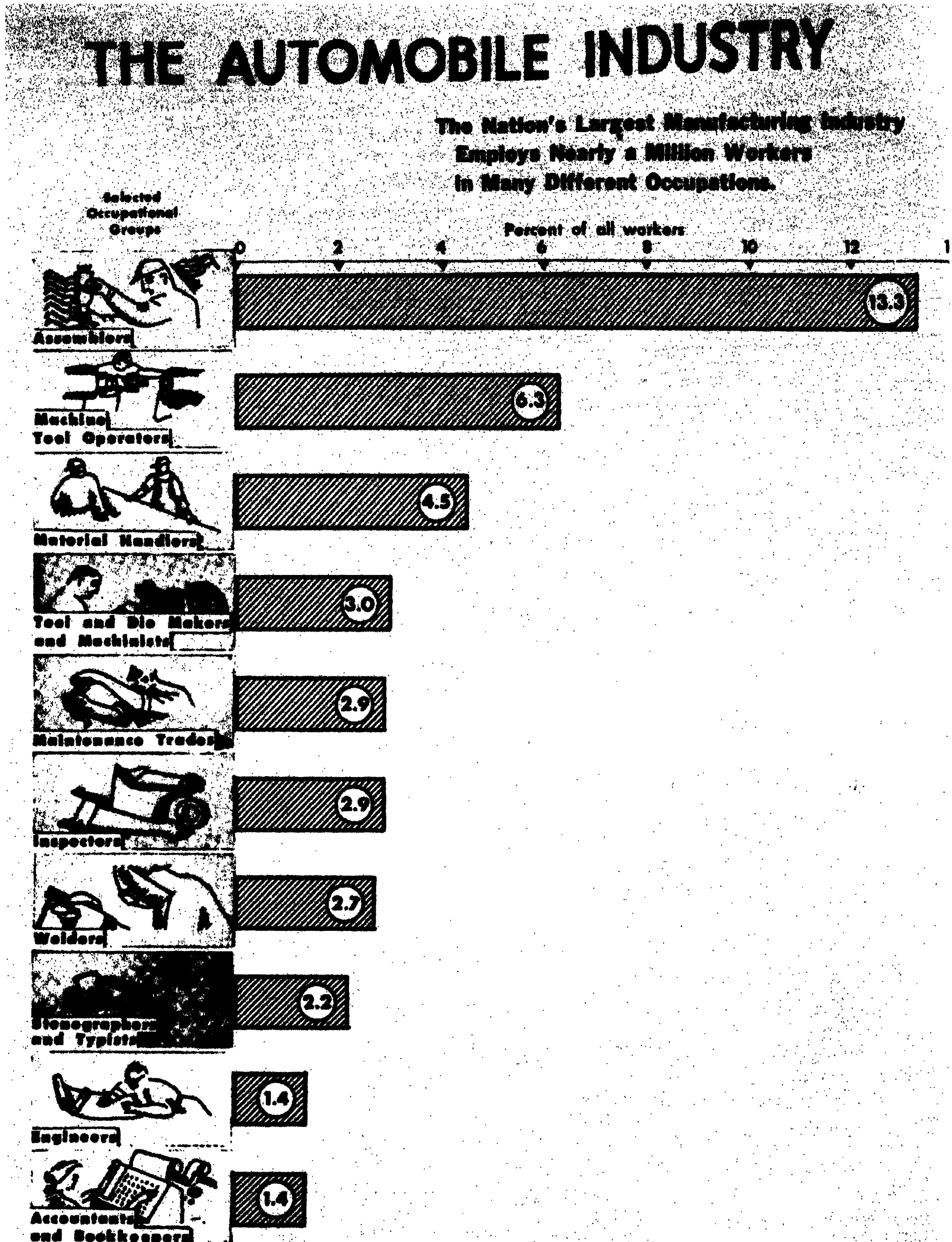
made into a line and curve graph must contain two elements. One is constant such as years, months, number of games, etc. This is always placed along the horizontal line, or abscissa. The other information varies or fluctuates, such as the number or percentage of items. This is placed along the vertical line, or ordinate.

4. Decide on the scale for the graph. The items that are constant must be placed equal distance apart. For example, in Fig. 36-1, there are five time periods. These can be placed as far apart as is convenient for the page. The items that vary will determine the scale along the vertical line. Divide this space into equal units with the top unit larger than the largest amount to be shown on the graph. For example, each space represents 25,000 men.

36-5. A triple bar graph.



Employment of technicians in industrial laboratories is rising rapidly.



36-6. A bar graph with illustrations.

5. Letter in the constant information along the horizontal line. Letter in the variables along the vertical line. Be sure to show what the numbers along the vertical line represent.

6. Locate or plot the points to make the graph line. Fig. 36-1 shows that there were 35,000 draftsmen working in 1910. Place a point on the 1910 line at 35. Do this for the other years.

7. Draw a heavy line to connect these points.

8. Add the title and source of information. Make the title brief and easy to read.

9. Points to remember:

a. Make sure that the line or curve stands out in contrast to the background of the grid.

b. Keep the graph as simple as possible.

c. If there is more than one line, label each one. If possible, make the lines of different quality or kind. Fig. 36-2.

d. Keep in mind the person who is going to read the graph.

BAR GRAPH

The bar graph is best for comparing such things as quantities, values, or percentages. The bars can be placed either vertical or horizontal. If there are many items, draw the bars horizontally with the longest bar at the top. Fig. 36-3. To make a simple bar graph, proceed as follows:

1. Determine if it is to be a vertical or a horizontal bar. For example, suppose you wished to make a graph comparing the number of students in various industrial classes in a certain high school. The enrollment is as follows: woodworking, 200; drawing, 175; metalwork, 150; electricity, 110; graphic arts and printing, 90. To show this information, a vertical bar graph would be a good choice. Fig. 36-4.

2. Use cross-section paper or draw a series of horizontal lines. If the graph is on 8½" x 11" paper, make each line 1" away from the next. Letter each horizontal line with the units (in this case, 25). Always make sure there is one line beyond the largest bar.

3. Draw the bar a convenient width. Always have a space about equal to the width of the bars between them. Place the bars in order from the smallest to the largest. Fill in the bars to make them look solid.

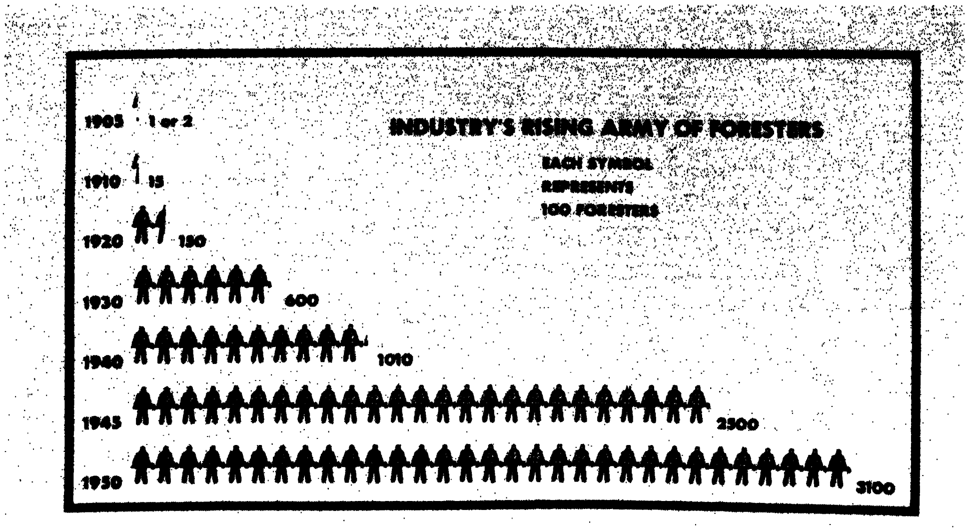
4. Place a label at the bottom of each bar.

5. Add the title and source.

Sometimes double or triple bars are used to compare similar items. Fig. 36-5. Make sure that you show clearly what each bar means by cross hatching each one in a different way. Always add a legend or code to identify each kind of bar. Sometimes bar graphs are made more interesting by adding a picture to illustrate what each bar represents. Fig. 36-6.

PICTORIAL GRAPH

The pictorial graph is a form of bar graph. Instead of using bars of dif-



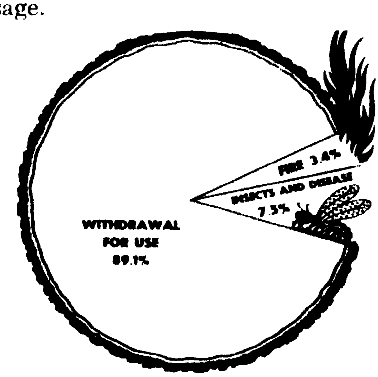
36-7. A pictorial graph.

ferent lengths, pictures or symbols are used. This makes the graph much more interesting to the reader. Fig. 36-7. There is no standard set of symbols to use on pictorial graphs. The symbols should clearly represent the items.

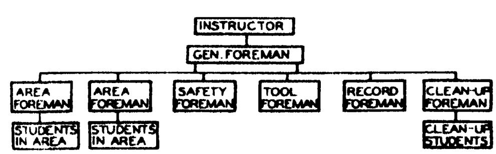
CIRCLE, PIE, OR SECTOR GRAPHS

This kind is very good for comparing information that totals 100 per cent. Fig. 36-8. The circle is divided into 360 degrees. Each 1 per cent equals 3.6 degrees. A quarter of the circle is 25 per cent. Suppose you wish to make a circle graph with the information on how the average family spends money: food and drink, 35 per cent, housing, 25 per cent; clothing, 15 per cent; transportation, 8 per cent; medical care, 6 per cent; other items, 11 per cent. First draw a circle of the desired size. Since the food item is 35 per cent, it would equal 126 degrees (35 x 3.6). Lay this angle off with the protractor and draw a line from the circumference

36-8. Circle or pie graph showing lumber usage.



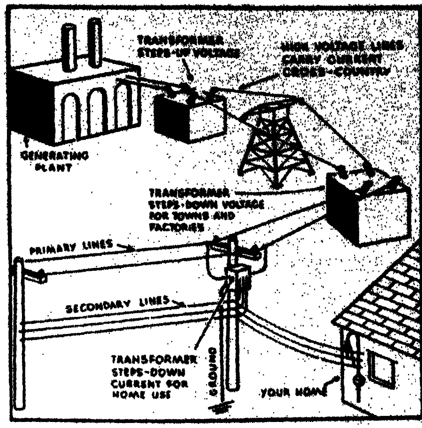
36-9. An organization chart used in the school shop.



to the center. Do this for each item of expenditure. Letter in each section of the pie, telling what each section represents and the percentage. Add a title.

CHARTS

Charts are a method of showing how things and people are related. The most common are organization and flow charts. The organization chart is used to show how people in any organization are related. In the school shop, for instance, there will be an organization chart showing how the shop is to be cared for. Fig. 36-9. The chart shows the positions of each person and to whom he is responsible. The flow chart shows how things are made, manufactured, and/or distributed. In Fig. 36-10 you see a flow chart showing how electricity is generated and distributed.



36-10 A flow chart.

PROBLEMS—SECTION V

Section V—QUESTIONS AND TOPICS FOR DISCUSSION

1. What is an architectural drawing?
2. What kind of paper is best for making a room arrangement or shop layout?
3. How would you go about making a room arrangement or shop layout?
4. What are the steps in planning an addition to a building?
5. Why should you keep in mind the stock sizes of materials when you make plans?
6. In what ways can your lumber dealer help you in building an addition?
7. Should you expect to be able to make the complete plans for a home yourself? Explain.
8. How can the total cost of the house be estimated?
9. Describe the following: floor plan, elevation, detail elevation, section, pictorial rendering.
10. What are built-ins?
11. What, exactly, is a map?
12. Name the kinds of maps.
13. What sort of information is best shown on a line and curve graph?
14. Describe a bar graph. What is it used for?
15. What does the pictorial graph show?
16. What is a pie, or circle, graph? When is it used?
17. Describe charts and tell how they are used.

Section V — SELF-CHECKING WHAT YOU HAVE LEARNED

PART I. True-False

1. There are about ten basic trades in the building industry.
2. When planning a home workshop an important step is to make a scale drawing of the area.

3. Planning an addition is a good way to become acquainted with architectural drawing.

4. There should be two square feet of vents for each 100 square feet of floor space.

5. Toenailing means to drive nails in at an angle.

6. Two common arrangements for kitchens are the V shape and the T shape.

7. Maps of the same area of land can be made for many different purposes.

8. There is always a scale on a road map to help in finding the distances between cities.

9. The distance between Chicago and New York would be shown in the same way on both an airline map and a highway map.

10. The White House is located on Constitution Avenue in Washington, D. C.

11. Chicago is in the Eastern Standard Time zone.

12. A plat map describes in detail a piece of city property.

13. The vertical line near the right or left edge on a line graph is called the abscissa.

14. Bar graphs are always made with the bars vertical.

15. The circle graph can be used with information that totals 50 per cent.

PART II. Fill In

1. Drawings of buildings where people live and work are called ________ drawings.

2. To make a room layout use a scale of________ inch equals one foot.

3. Cutouts or________ to scale should be made of all pieces of furniture when making a room layout.

4. In planning an addition always measure the________ to be included in the new addition.

5. The standard size of wallboard is ________ feet.

6. A________ is a vertical member of a wall or partition.

7. The supporting member to which floor and ceilings are fastened is called a________.

8. In an older house the two rooms that usually need to be remodeled first are the ________ and the________.

9. Studs are usually placed________ inches apart when building a house.

10. The base for studs and joists in a house is called a________.

11. The total cost of a house should not exceed________ times the annual income of the owner.

12. Plans that show a view of the inside of the house looking down from the top called________ plans.

13. The view that shows how the house looks from one side of the outside is called a________.

14. To show the carpenter how to build the kitchen cabinets in a home the architect will draw a________ elevation.

15. Perspective drawings of a house show how it will look and are called ________ drawings or pictorial.

16. A map is a________ drawing of some part of the world.

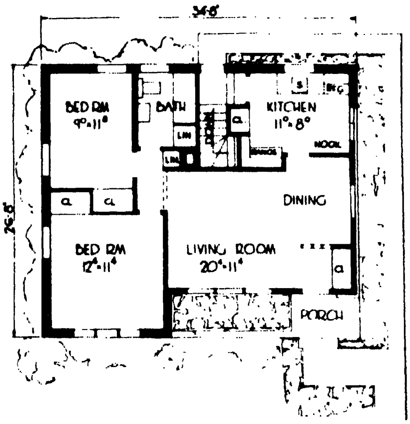
17. The________ Memorial is located on the shore of the Tidal Basin in Washington, D. C.

18. The most complete map of an area is called a________ map.

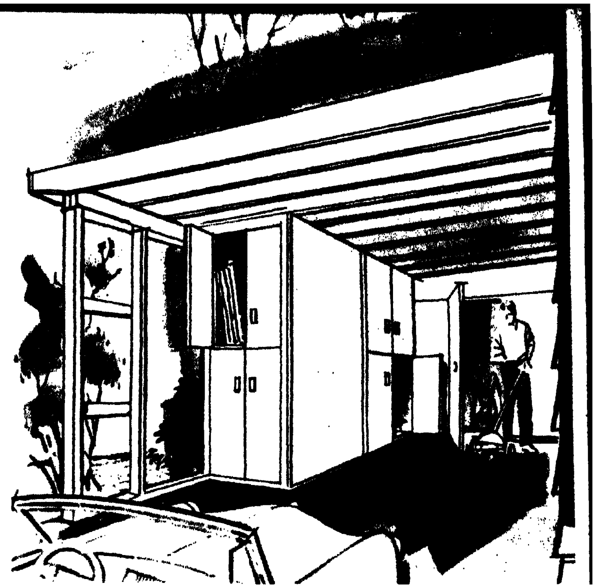
19. ________ lines on a map show elevation.

20. The line and________ graph is used to show what has happened or what might happen.

21. A pictorial graph is a form or kind



V-A-4



V-A-6

of ___ __ graph.

22. The circle, or pie, graph is sometimes called a __ __ graph.

23. A student personnel and clean-up chart used in the school shop is a kind of ___ chart.

24. A chart that shows how steel is manu- ___ chart.

Section V—APPLYING WHAT YOU HAVE LEARNED: ACTIVITIES, THINGS TO DO, PROBLEMS, EXPERIENCES

A. Layouts and Architectural Drawings

1. Make a layout of your own room to scale (¼"=1'). Make cutouts or templates of the furniture. Make a cutout for some new piece of furniture such as a desk or chest and rearrange your room.

2. Make a layout for a home workshop that includes a bench, jig saw, circular saw and jointer.

3. Find the number of square feet of floor space in the floor plan shown in Fig. 34-26. Ask a builder in your city the cost per square foot and figure the approximate cost of the house.

4. Determine the number of cubic feet in this house. Fig. V-A-4. If the average height is 11 feet and the cost per cubic foot is $1.20, what would be the cost of the building?

5. Using the layout shown in Fig. 34-15, make a desirable kitchen arrangement.

6. Complete a floor plan of a carport such as is shown in Fig. V-A-6. The overall size of the garage is 18' x 22'.

7. Make a rough floor plan for a cabin. Fig. V-A-7. Include a living room, kitchen, bath and two bedrooms.

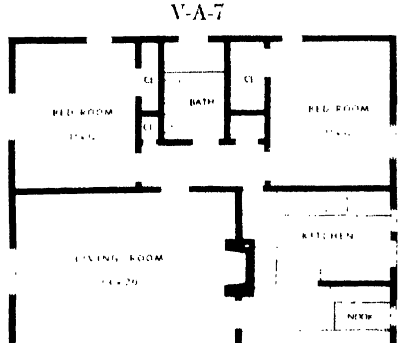
8. Make a floor plan to scale of a basement recreation room. Fig. 34-6

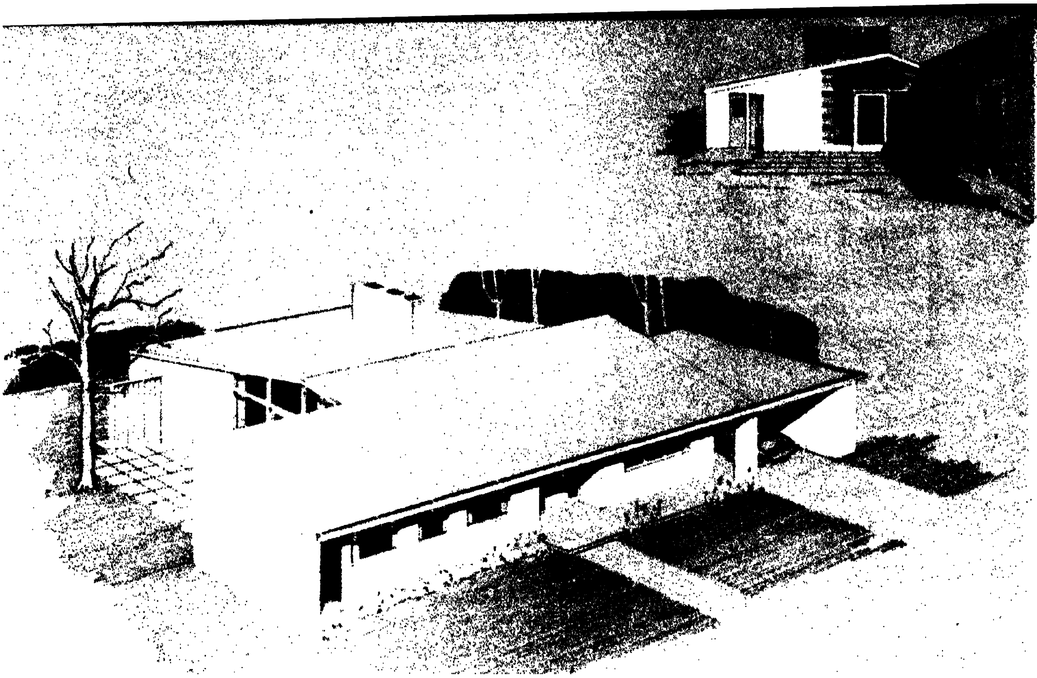
9. Make a scale drawing of the floor plan shown in Fig. V-A-9.

B. Maps

1. Sketch a map showing how to get from your home to school.

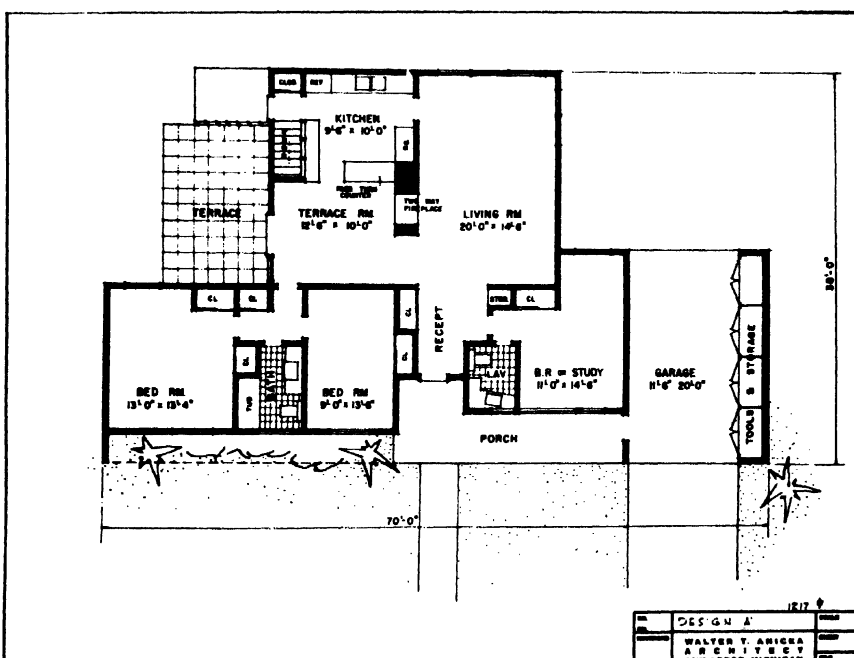
V-A-7





V-A-9A

V-A-9B


KITCHEN
9'-6" x 10'-0"
TERRACE
TERRACE RM
12'-6" x 10'-0"
TWO WAY FIREPLACE
LIVING RM
20'-0" x 14'-6"
CL
CL
CL
CL
STOR
CL
RECEPT
BATH
LAV
BED RM
13'-0" x 13'-4"
BED RM
9'-0" x 13'-6"
B.R or STUDY
11'-0" x 14'-6"
GARAGE
11'-6" 20'-0"
STORAGE
TOOLS
PORCH
70'-0"
38'-0"
1217
DESIGN A
WALTER T. ANICKA
ARCHITECT
ANN ARBOR, MICHIGAN

THE MAJOR FIXED APPLIANCES FOR THE HOME
Electrical Capacity, Consumption and Energy Expense

Fixed Appliances	Average Wattage*	Est. Annual KWH*	Average Monthly Operating Expense 2c KWH
KITCHEN			
1. Refrigerator	205	350	.58
2. Range	10800	1200	2.00
3. Fan	85	50	.08
4. Dishwasher	1155	305	.50
5. Food Waste Disposer	330	25	.04
LAUNDRY			
6. Water Heater	2500	3600	6.00
7. Automatic Washer	1000	45	.07
8. Clothes Dryer	4350	660	1.10
9. Ironer	1500	155	.25
UTILITY ROOM			
10. Furnace Fan	225	255	.42
11. Oil Burner	245	315	.52
12. Stoker	250	270	.45
13. Heat Pump	(3&5 HP)	Varies with Local Conditions	
14. Electronic Air Cleaner	60	480	.80
15. Air Conditioner (Central)	(2 to 5 HP)	Varies with Local Conditions	
16. Water Pump	265	185	.30
17. Dehumidifier	210	270	.45
18. Home Freezer	255	680	1.13
MISCELLANEOUS			
19. Attic Fan	370	260	.43
20. Room Air Conditioner	800	965	1.60
21. Bathroom Heater	1095	100	.16

*Source: Edison Electric Institute, except Automatic Washer and Electronic Air Cleaner Data.

V-C-4

2. Make a plat map of your block to scale.

3. Plan a trip from your home to a large city in your state or to some park or place of scenic or historical interest. Use a road map and make a trip map showing the routes you would take and the distances.

4. Letter in the capitals and the states of the United States. Trace a map as shown in Fig. 1-18.

C. Charts and Graphs

1. Make a line graph showing the increase in the number of engineers in the United States between 1900 and 1950.

1900–40,000
1910–90,000
1920–130,000
1930–200,000
1940–260,000
1950–400,000

2. Construct a horizontal bar graph to show five of the leading home run hitters of the major leagues. V-C-2

3. Construct a triple bar graph to compare distances in major league baseball parks. V-C-3

4. Construct a bar graph to show the average monthly operating expense of the common appliances found in a kitchen. V-C-4

Country	Population	Land Area	Electricity	Production Percentage
United States	7.0%	6.00%	46.2%	32.2%
Great Britain	2.2	.17%	6.0	9.2
France	1.8	.34%	2.1	4.5
Italy	2.1	.2	1.8	2.7
Sweden	0.3	.31	1.8	1.3
Russia	8.8	14.00	5.0	18.5
Rest of World	77.8	78.98	37.1	31.6

V-C-6

All-Time Home-Run Hitters in Major Leagues (to 1957)

American	Total	National	Total
Babe Ruth	714	Mel Ott	511
Jimmy Foxx	534	Ralph Kiner	369
Lou Gehrig	493	Johnny Mize	359
Ted Williams	432	Stan Musial	354
Joe DiMaggio	361	Rogers Hornsby	302
Hank Greenberg	331	Chuck Klein	300
Al Simmons	307	Hank Sauer	270
Bob Johnson	288	Gil Hodges	266
Rudy York	277	Cy Williams	251
Joe Gordon	253	Hack Wilson	244
Goose Goslin	248	Wally Berger	242

V-C-2

5. Construct a vertical bar graph comparing the average lifetime earnings of the following. Before World War II, the average lifetime earnings of non-high school graduates was $45,000.

Non-high school graduate—100%
High school graduate—175%
College graduate—225%

6. Construct a circle or pie graph using any of the information in V-C-6.

Distances in Major League Baseball Parks

League	L.F.	C.F.	R.F.
American League			
Municipal Stadium, Baltimore	291	410	291
Fenway Park, Boston	315	420	302
Comiskey Park, Chicago	352	415	352
Municipal Stadium, Cleveland	321	410	321
Briggs Stadium, Detroit	340	440	325
County Stadium, Kansas City	334	440	331
Yankee Stadium, New York City	301	461	296
Griffith Stadium, Washington	408	426	328
National League			
Coliseum, Los Angeles	250	440	300
Wrigley Field, Chicago	355	400	353
Crosley Field, Cincinnati	328	387	366
County Stadium, Milwaukee	320	402	320
Seal Stadium San Francisco	372	412	295
Connie Mack Stadium, Philadelphia	334	440	331
Forbes Field, Pittsburgh	335	457	300
Busch Stadium, St. Louis	351	422	310

V-C-3

7. Construct a pupil personnel chart for your shop.

8. Construct a student organization chart for one of the organizations of your school.

Section VI: DRAWING INFORMATION

HERE is a *preview* of the things you will learn in *drawing information*. . . . what you should know and be able to do after you have studied the units in this section:

1. What blueprints are.
2. Where they are used.
3. How they are made: the sun frame, the blueprint machine.
4. Other methods of reproducing drawings.
5. The kinds of drawings needed for an industry and in building and construction.
6. How these drawings are put to use.
7. Who are the people who use these drawings in their jobs.
8. How many there are and how they get their training.
9. Opportunities in the jobs and occupations.
10. A test to see if you would be interested in one of these jobs or occupations.

Section VI

37. How Prints Are Made

Blueprints, or prints, are exact copies of mechanical drawings. You've heard of people getting a set of blueprints for the new house they are planning to build. These are copies of the original drawings made by the architect. They are called blueprints because the paper has a blue background with white lines. Most *copies of drawings* are called blueprints even though they are not always blue in color.

HOW PRINTS ARE MADE

In manufacturing, building, and construction it would not be possible or desirable to use the original drawings. They would become soiled and worn out. Then, too, many workmen have to handle the drawings at the same time, so several sets have to be made. In general, prints are made about as follows:

A thin sheet of transparent tracing paper or cloth is placed over the original drawing. The drawing is traced on this paper with pencil or ink. Fig. 37-1. This is called a *tracing*. This tracing is then used in the same way a negative is for making snapshots. That is, the tracing is placed over some chemically treated paper and exposed to light. The treated paper is then developed to show the lines of the drawing.

USING A SUN FRAME

The simplest way to make a blueprint is with a sun frame. This is much like a picture frame. It has a glass-and a felt-covered back that can be easily removed. Fig. 37-2. The print is made on chemically treated blueprint paper. This paper is light green before it is exposed to light. It must always be kept in a covered metal box or can because sunlight ruins it. There are several different grades of blueprint paper. They develop at different speeds.

Cut the paper to the size of the tracing. Before making the actual print make a test print. Cut three small squares of paper and expose

37-1. Making an ink tracing. Most tracings are made with a pencil, however.

them to light at 1, 2, and 3 minutes. Then wash the paper in water. Compare these to see which has the best blue color.

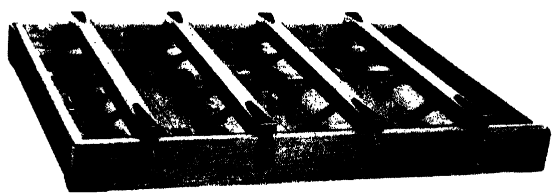
Place the tracing face down on the glass. Place the blueprint paper with the yellow side against the tracing. Expose the print to the sunlight for the desired length of time. Fig. 37-3. *During the winter in northern states* only the middle of the day is practical. Remove the exposed paper and wash it in clear water to develop it. If the print is too light or too dark, wash it in a fixing solution of potassium bichromate (one ounce to a gallon of water). Hang the print on a line to dry. It can also be dried by placing it on a glass or metal surface and removing the water with a squeegee.

BLUEPRINT MACHINE

Blueprint machines make prints quickly and easily in much the same way as sun frames. Fig. 37-4. There are many different sizes. On small ones the blueprint paper is cut to size and fed into the machine one sheet at a time. On large machines the process is a continuous one with the paper and tracing starting in at one end and the dry print coming out the other.

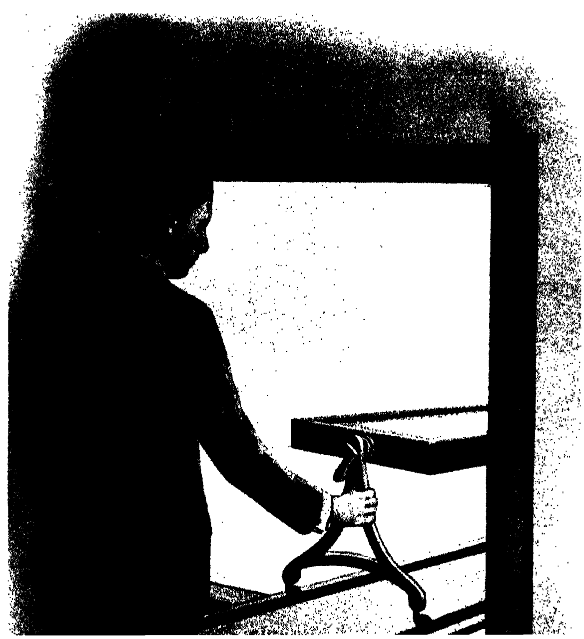
In blueprint machines the tracing is placed over the sensitized blueprint paper. Together they are fed into the front of the machine where they go under strong arc lights. The original yellow paper turns a greyish blue. The tracing is removed and the print washed in clear water. The paper turns blue with white lines. The print is then washed in potassium bichromate solution to darken it. It is washed again in water and then dried.

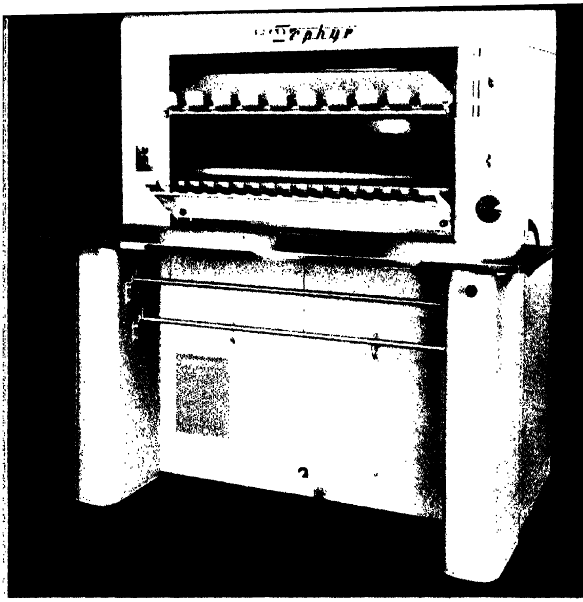
The disadvantage of blueprint printing is that the paper tends to shrink a little as it goes through the washing and drying. The chief advantage is that the finished print does not fade when exposed to sunlight. For this reason it is used very much in the building trades.



37-2. The sun frame can be used to make prints.

37-3. Using a sun frame to make a blueprint.

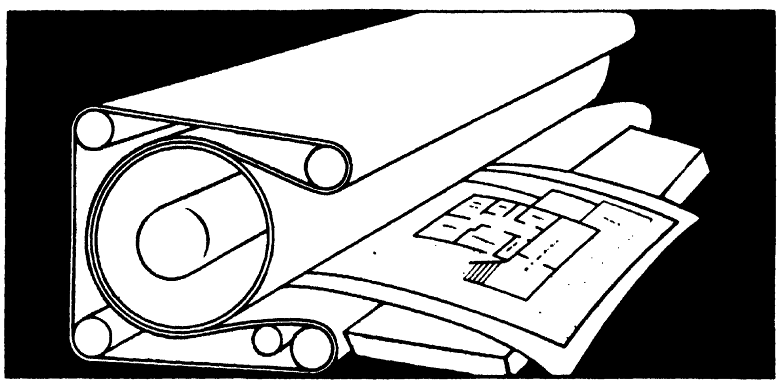




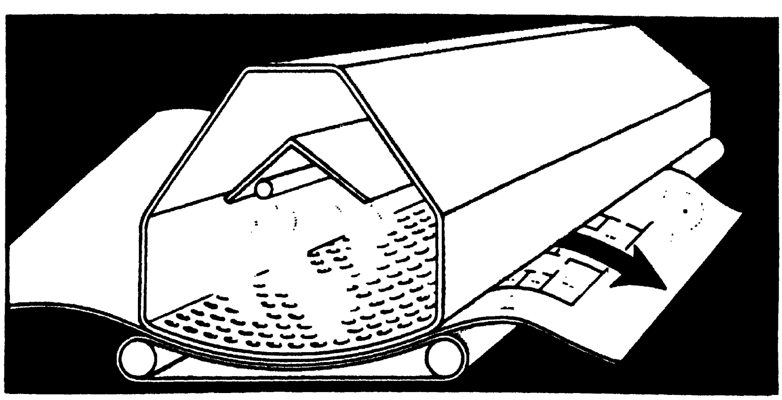
37-4. A print machine.

OZALID PROCESS

This print has a white background with black, blue, or maroon lines, depending on the kind of sensitized paper used. A tracing is placed over the sensitized paper. This is fed through the printer, which exposes it to strong light. Fig. 37-5. The tracing is then separated from the paper and the sensitized paper fed through a developer that exposes the paper



37-5. Exposing a print in the ozalid process.



37-6. Developing a print in the ozalid process.

37-7. A drafting machine eliminates the need for T square, triangle and protractor. Notice that the lighting is wrong, and throws the draftsman's shadow on his work.

to ammonia fumes. Fig. 37-6. This produces a print that comes out of the machine perfectly dry. The print does not shrink at all and is smooth. Because of the white background, changes can easily be made on the print with pencil or ink. Fig. 37-7.

MIMEOGRAPH

A common way of duplicating drawings in many schools is by mimeograph. The original drawing is placed over clear glass in a frame. Underneath is a bright light. A stencil is placed over the drawing. The drawing is traced or cut on the stencil with special tools called styluses. After the stencil is cut it is placed on a mimeograph machine and the copies run off.

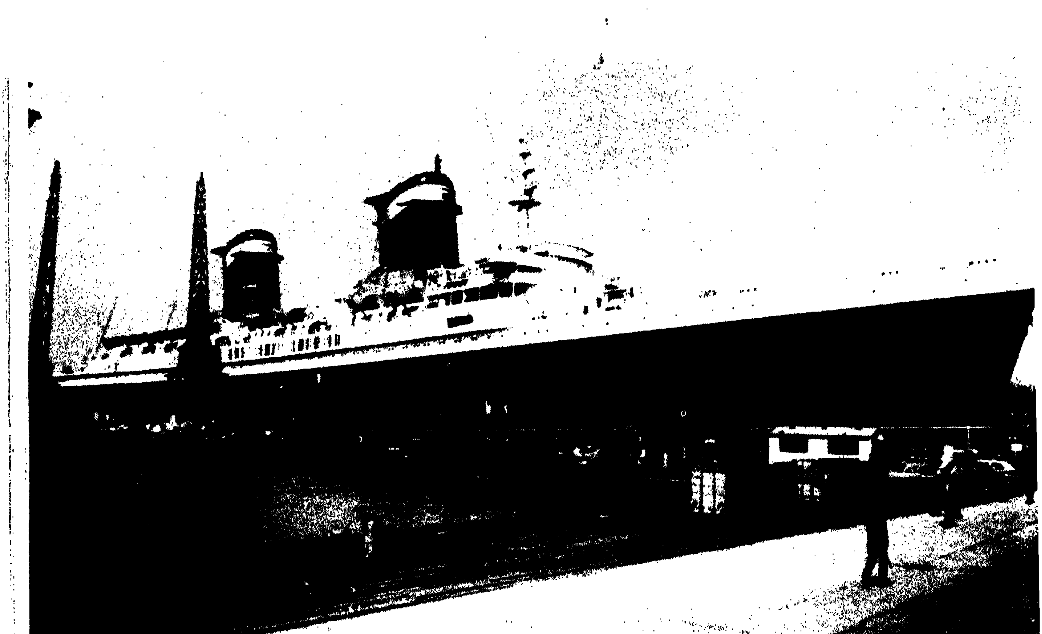
There are many other ways of reproducing drawings that are not so common as the ones described here.

38. How Drawings and Prints Are Usec in Building and Industry

If you were asked the question, "Who built the United States," you would probably answer with the names of many of our great leaders, past and present. Suppose, though, that you were asked this same question concerning the biggest, safest, most beautiful merchant ship ever built in America. It too is called the United States. To this you would probably have to answer that you do do not know the names. Yet, t men are helping to build our cou in a different and very important

This mighty titan of the sea is feet long. Fig. 38-1. Turned on e would be only about 140 feet sh than the Empire State Building! l look at the people who built this g ship. First there were the archit engineers, designers, and draftsn These men worked for years to

38-1. The super liner S. S. United States.



38-2. Working on designs for a new automobile.

duce the design and the *8,400 detailed drawings* necessary. From these drawings, 72 *tons of blueprints* were made! These prints were used by the thousands of skilled workers who built the parts and assembled this great ship. What these men have done is much like what you are learning to do. First you develop an idea for the design, then you make a drawing, then you use this drawing to make or build the object. You are the designer, architect, engineer, draftsman, and skilled worker all in one.

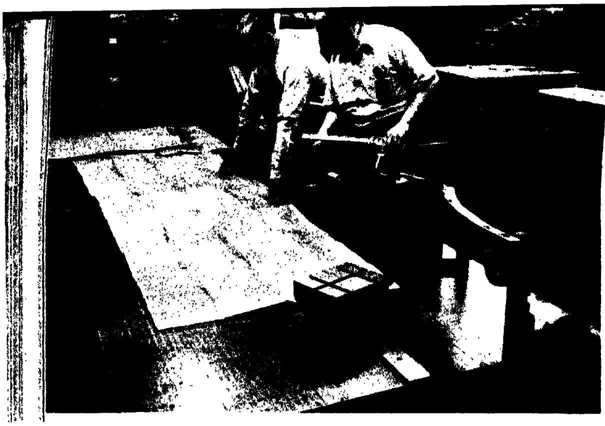
HOW DRAWINGS AND PRINTS ARE USED IN INDUSTRY

Let's trace a product from the idea to the finished article and see how drawings and prints are put to use. First the executives of a company decide that a new product or a new model of an old one is to be manufactured. The industrial designer and his staff then go to work to make the needed sketches. Fig. 38-2. The industrial designer works with a group of engineers. Often a complete scale model of the object is made. Fig. 38-3. The engineers must decide on whether the product can be built to the design standards.

After the designs are approved, the draftsmen make working drawings of all the detail parts, of the sub-assemblies, and of the complete assemblies. These drawings are then given to the tool designer. He works from these drawings to design the new tools, fixtures, jigs, and machines needed to produce the parts. When his work is completed the tool and die makers (skilled machinists) use these drawings to build and make the tools, dies, fixtures, and jigs.

The raw materials must also be purchased for the new product. Here the prints are followed closely to determine what kind and how much of each material to order. The tools and machines must be set up and made ready to go. The assembly line must also be developed for putting together the parts. Finally, by using the prints, each part is made and checked. Fig. 38-4. The parts are put together in sub-assemblies and the finished product is assembled as it moves along an assembly line.

38-3. Making le model of the new design.



38-4. Using a print to check one part of the automobile.

All of this activity goes on year after year each time a new product or re-design of an old one is developed. One manufacturer alone may spend 100 million dollars to produce just one new design of his product—a product that you and I would be satisfied with for only two or three years! Then we'll want a new model, so the procedure of making designs, drawings, and prints must be repeated over and over again.

Section VI

39. How People Earn a Living in Drawing

After you've made some drawings you will want to learn about some of the occupations in this field. The skills you have learned are similar to those developed by many men in their everyday work. Over three quarters of a million men and women work at jobs in which they must know how to do drawing and designing. There are millions of others who work at jobs in which they must be able to read drawings. If you like drawing, then you should consider some of the occupations in which these skills are needed. Remember: everything of any consequence that is built must first be drawn.

DRAFTSMEN

Draftsmen make the working drawings used in manufacturing, in building, and in other construction. Today there are over 125,000 men employed in this occupation, and the number is growing very rapidly.

Draftsmen usually start out doing tracing. In this job they copy the work of other draftsmen in preparation for making prints. The next step "up the ladder" is becoming a detailer. This man draws some small part that has been sketched for him by a senior draftsman or engineer. His next step will be to advance to the job of the junior draftsman. Here he will have many more responsibilities for making the drawings. The senior or chief draftsman is responsible for the overall work in his department.

To be a good draftsman you must have the ability to *imagine what something will look like* after it is completed. Not all people can look at a drawing and do this. You must also be *accurate and neat* in your work, since this is basic to making good drawings. Some *ability in mathematics* is needed because all drawings have dimensions and measurements. The draftsman must also know about the *materials of industry,*

39-1. A draftsman at work.

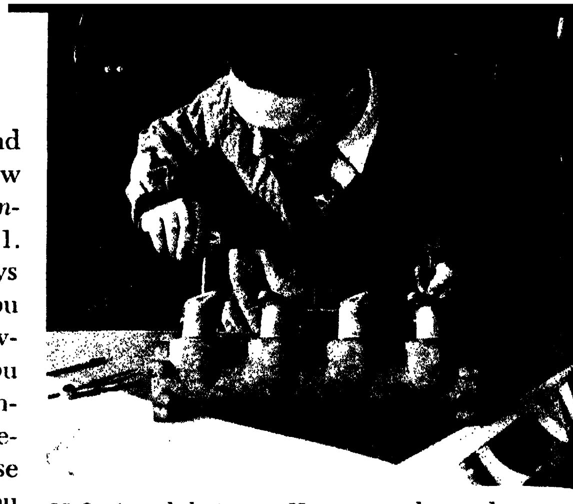
including their sizes, shapes, and characteristics. And he must know something about how things are *constructed and manufactured.* Fig. 39-1.

There are at least two good ways of becoming a draftsman. (1) You can begin by taking all of the drawing possible in high school. Then you can go to a trade, vocational, or technical school and take a one- to three-year program in this trade. In these schools, in addition to drafting, you will study math, science, English, and common manufacturing processes. (2) A second way is to serve a three- or four-year apprenticeship in the trade. Here you sign a contract to work with experienced draftsmen until you have learned the trade.

Wages and salaries of draftsmen are somewhat lower than other trades during the early years. However, with experience and training come many opportunities. Most draftsmen specialize in some area of work such as architectural, structural, mechanical, aeronautical, electrical, marine, or map drafting. They usually work for private drafting companies, manufacturers, or for the government.

TOOL DESIGNERS

The tool designer works from the drawings made by the industrial designer and engineer. He first makes sketches of the design for the tools, dies, jigs, and fixtures that are needed to make the parts of a product. Fig. 39-2. These sketches are made into working drawings and checked to see if they are correct and will work. The drawings are then given to the tool and die makers who build the



39-2. A tool designer. He must understand all types of manufacturing processes.

tools and fixtures. The tool designer must have a good understanding of designing processes, including machines and drawing. He must know all about materials and how they can be worked. Most tool designers start as draftsmen or machinists. They receive additional training and eventually become experts in their field. Many former industrial arts teachers become tool designers because of their general knowledge of drawing and machine shop.

PROFESSIONS IN DRAWING

If you plan to go to college, there are many other occupations open to you in drawing and design.

Architects. The architect designs all kinds of new homes and buildings. Most architects specialize in home designing or commercial, industrial, or public structures. Fig. 39-3. There are about 30,000 in the United States. To enter this profession it is necessary to get a college degree that may take four to five years. Then most architects spend a year or two work-

ing for a large firm, getting practical experience. Most states require that architects be licensed, especially when the health and welfare of people are the concern of these architects. Most architects are self-employed.

Before designing a new building or home, the architect calls on the people concerned to discuss such things as location, size, cost, and materials. He then makes preliminary sketches, including a pictorial drawing or rendering of the proposed building. After these are checked and okayed by the client, he and his draftsmen prepare detailed drawings of the structure to be used by the contractor or builder. Often he will also arrange for a contractor and will help to supervise the construction.

39-3. An architect.

This occupation offers wonderful opportunities for anyone who is creative.

39-4. Engineers at work in a large airplane manufacturing plant.

Industrial Designers. These are the men who design the new car models, refrigerators, and other things we buy and use. The industrial designer usually works for a large company or for an independent concern that does designing. Usually the designs are made in the form of pictorial drawings or models. The designer must be artistic and creative and be able to draw. He works closely with engineers in deciding if the product can be built. Designers usually specialize in some area such as automotive, electrical, furniture, or fur design. The industrial designer must have a good background in art, manufacturing processes, mathematics and other areas dealing with business and industry. Most industrial designers have a college degree. Some of them transfer from drafting, commercial art or teaching. Many, however, are trained in college as industrial designers.

Teachers. If you like drawing and shopwork you will find many opportunities in teaching. There are about 40,000 industrial arts teachers who teach drawing either as a part-time or full-time activity. Some teach in general shops while others teach full-time drawing. If you like to work with other people, if you like the freedom teaching gives, and if you want to be of service to others, you should consider teaching. There are plenty of chances for advancement. Many who go on to college to major in Industrial Arts enter business and industry, where they become tool or industrial designers or work in engineering.

Engineering. Engineering is the largest profession open primarily to men. There are over 400,000 engineers in the United States and this number is growing rapidly. Engineers do designing, building, testing, and operating of the things we use and live with. Fig. 39-4. Engineers usually specialize in mechanical, electrical, chemical, civil, or other engineering. Every engineer must learn basic drawing and also the engineering drawing necessary to his specialty. There is a tremendous need for more engineers. If you are good at math, the sciences, and drawing, you should consider this profession.

Self-Test. Can you be a draftsman, teacher, designer, or engineer? Here is a simple test to help you to find out if you're interested in becoming a draftsman or would like to become a member of one of the professions named above.

1. Do you like mechanical things?
2. Do you like to build things such as models?
3. Are you neat and accurate in your work?
4. Can you stay with a job until it is completed?
5. Are you pretty good in math and science?
6. Can you see something on paper and imagine how it really looks?

If your answer is "yes" to all of these questions, then you might consider an occupation in which drawing and designing are important.

PROBLEMS—SECTION VI

Section VI—QUESTIONS AND TOPICS FOR DISCUSSION

1. What is a blue print?
2. Why are blueprints necessary?
3. How are blueprints made on the sun frame?
4. Describe the process of the blueprint machine.
5. What is the chief advantage and disadvantage of blueprints?
6. Name other processes of reproducing prints.
7. Name the people who are involved in creating and building a new product.
8. Who is the first man to begin the work?
9. What is the job of the engineer?
10. Who makes the working drawings?
11. Who uses the working drawings?
12. What is the work of the tool and die maker?
13. Describe the following occupations: draftsman, tool designer, architect, industrial designer, industrial teacher, and engineer.
14. What training and/or education is required for each of these occupations?

Section VI — SELF-CHECKING WHAT YOU HAVE LEARNED

PART I. True-False

1. All prints are blue in color.
2. A blueprint is an exact copy of a mechanical drawing.
3. It is necessary to have expensive equipment to make a blueprint.
4. The paper used for making prints must always be kept in a covered metal box or can.
5. Blueprints are wet when they are first developed.
6. Blueprints fade a good deal when exposed to sunlight.
7. In the ozalid process the color of the lines depends on the kind of print paper used.
8. A common way of duplicating drawings in the school shop is by mimeograph.
9. A full-scale model of a product is usually made before the product is built.
10. A detailer is a more experienced workman than a junior draftsman.
11. The draftsman must know about the materials of industry.
12. All draftsmen must attend a trade, vocational or technical school to learn their trade.
13. Most tool designers start as draftsmen or machinists.
14. Most architects work for some large company.
15. Engineering is the largest profession open primarily to men.
16. There are about 40,000 Industrial Arts teachers in the United States.

PART II. Fill In

1. A______ is a drawing made on a thin sheet of transparent paper or cloth and used for duplicating.

2. A______ is a simple device used for making a blueprint.

3. To develop a print in the ozalid process, the paper must be exposed to______ fumes.

4. The largest passenger ship ever built in this country is called the______.

5. It was necessary to make______ tons of blueprints to use in building this largest ship.

6.______ are thé professional men who must decide if a product can be built to the design standards.

7. The men who make the working drawings used in manufacturing and building are called______

8. A man who makes the drawings for the new tools, jigs, and fixtures is called

9. There are about ___ thousand architects in the United States.

Appendix

A. Sources of Project Plans and Materials

1. Atlas Press Company
   North Pitcher Street
   Kalamazoo, Michigan
2. Casting Specialties
   Thiensville, Wisconsin
3. Reynolds Metals Company
   2500 South Third Street
   Louisville, Kentucky
4. California Visual Aids Company
   6214 W. Manchester
   Los Angeles 45, California
5. Rohm & Haas Company
   Washington Square
   Philadelphia, Pennsylvania
6. Allied Radio Corporation
   100 N. Western Avenue
   Chicago, Illinois
7. Joseph Dixon Crucible Co.
   Jersey City 3, New Jersey
8. X-Acto, Inc.
   48-41 Van Dam Street
   Long Island City, New York
9. Skil Corporation
   5033 Elston Avenue
   Chicago, Illinois
10. Woman's Day Magazine
    19 West 44 Street
    New York 36, New York
11. Osborn Brothers
    223 Jackson Boulevard
    Chicago, Illinois
12. Metal Goods Corporation
    5329 Brown Avenue
    St. Louis, Missouri
13. McCoy Products Company
    2509 Higuera Street
    Culver City, California
14. McCall's Patterns
    Dayton 1, Ohio
15. Douglass Fir Plywood Association
    1119 A Street
    Tacoma Washington
16. Strombeck-Becker Manufacturing Com-

B. Other Cooperating Companies

Allis-Chalmers Manufacturing Co.
Chrysler Corporation
Ford Motor Company
Canadian Forest Products Limited
Plywood Manufacturers Association of British Columbia
Eugene Dietzgen Co.
Weyerhaeuser Sales Company
The American Magazine
The H. M. Harper Company
Masonite Corporation
National Carbon Company
Popular Home Magazine
Eagle Pencil Company
Great Northern Railway Company
The A. C. Gilbert Co.
Berkroy Products Co.
Association of American Railroads
Westinghouse Electric Corporation
Behr-Manning Corporation
The Wool Bureau Incorporated
Pittsburgh-DesMoines Steel Company
A. G. Spalding & Bros. Inc.
Herman Miller Furniture Co.
Sprague & Carleton, Inc.
Conant Ball
California Redwood Association
The Brandt Cabinet Works, Inc.
Texas Highway Department
E. H. Sheldon Equipment Company

H. & A. Selmer Inc.
General Drafting Co., Inc.
National Electrical Contractors Association
The C. F. Pease Company
Ozalid—A Division of General Aniline & Film Corporation
Southern Pine Association
New Departure—Division of General Motors Corporation
National Gypsum Company
National Adequate Wiring Bureau
Automobile Club of Michigan
Fisher Body Craftsman's Guild
Herkimer Tool and Model Works, Inc.
The Lionel Corporation
The Westfield Manufacturing Co.
Butler Specialty Company
Keuffel & Esser Co.
Erwin J. James—Architect-Engineer
Harley-Davidson Motor Co.
Eberhard Faber Pencil Company
Milton Bradley Company
Bicycle Institute of America Inc.
American Type Founders, Inc.
American Standards Association, Incorporated
American Screw Company
American Builders
American Airlines
Ho Planners Inc.
U. S. Department of Agriculture
U. S. Department of Commerce
U. S. Department of Labor
K. V. P. Company
Mayline Company, Inc.
Thomas A. Edison, Incorporated
American Cypress Association
United States Rubber Company
Alvin & Co.
The Bryant Electric Company
Sears, Roebuck and Company
Caterpillar Tractor Company
American Zinc Institute
Michigan Bell Telephone Company
General Electric Company
Allan Gould Designs
South Bend Toy Manufacturing Company
Southern Railway System
International Business Machines
The Frederick Post Company
Brammer Manufacturing Company
American Forest Products Industries, Inc.
Miller Lumber Company

Index

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References to ILLUSTRATIONS are in italics.